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COMMUTING IN A NEW CENTRUY

The New Program for Mass Transportation

Approved by the MBTA Advisory Board March 1, 1994

Executive Office of Transportation and Construction,
Commonwealth of Massachusetts

In cooperation with the
Massachusetts Bay Transportation Authority

In consultation with the
Executive Office of Communities and Development
Massachusetts Bay Transportation Authority Advisory Board
Massachusetts Highway Department
Metropolitan Area Planning Council

With the assistance of the
Central Transportation Planning Staff

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Chapter 1
Introduction

Since the Program for Mass Transportation was last updated, major improvements have been made to Massachusetts Bay Transportation Authority (MBTA) services: the Red Line extension to Alewife, restoration of commuter rail to Needham, a restored South Station, the new Orange Line, new rolling stock on all modes, and a dramatic upgrading of commuter rail and rapid transit service throughout the region. These improvements have benefited virtually all MBTA riders, and have helped to attract over 150,000 new daily riders to the MBTA system over the last 10 years. Today, approximately 940,000 trips are made daily on MBTA rapid transit, bus, commuter rail and commuter boat services. Increased transit ridership has reduced the pressure on the regional highway system and benefited regional air quality.

When many of these improvements were being made, Massachusetts was in the midst of an economic boom that resulted in tremendous increases in travel throughout the region. This new demand often outpaced growth in transit and highway capacity. Slower economic growth in the 1990s provides an opportunity to catch up and better plan for the future, but such a climate provides fewer public resources to do so. Therefore, the choices about how to meet the region's future transit needs are more difficult than they were in the past. This update to the Program for Mass Transportation (PMT) is a first step in addressing the needs and challenges of the next century.

The New PMT

The PMT is the mass transportation plan for the Boston metropolitan area. More specifically, as stated in M.G.L. Chapter 161A, Section 5(g), it is "a long-range plan for the construction, reconstruction or alteration of facilities for mass transportation within the area constituting the authority [MBTA] together with a schedule for the implementation of such plan and comprehensive financial estimates of cost and revenues." The objective of the PMT is *to identify and recommend projects that will result in a cost-effective transit system that serves the greatest number of people in a way that respects the environment and enhances responsible economic development.*

This will be the second major revision to the PMT. It was first prepared in 1966, with a major update in 1978. Since 1978, there have been dramatic changes in the region. These have included tremendous increases in employment, both in downtown Boston and in the suburbs. The increased number of jobs, combined with the dispersed population pattern of

the region and the high level of automobile ownership, has resulted in a high volume of travel on the regional highway system. Suburb-to-suburb commuting has become the dominant travel pattern in the region, comprising nearly 80 percent of all trips. At the same time, commuter trips to Boston, which represent the major market for transit, continue to grow in number and increase in length.

In order to maintain and improve the economic strength of the region, and provide new opportunities, we must ensure that the transportation system will be able to accommodate these new travel characteristics. At the same time, we must ensure that transportation improvements fit our environment in order to maintain the continued livability and desirability of our region.

The new PMT is intended to represent an ongoing program—as programs, projects, and policies evolve, the PMT will be updated as needed to reflect these changes. Flexibility is also needed in order to accommodate changing economic conditions and new technologies, as well as to respond to funding opportunities and constraints.

The Process for Developing a New PMT

The PMT addresses mass transportation needs through the year 2020 that involve capital expenditures. It includes facilities and services that operate within, and to and from, the MBTA district. The development of the new Program for Mass Transportation has been conducted in three phases:

Phase 1 – Initial Study of Potential Transit Improvements

The first phase consisted of an initial study of potential transit and transit-related improvements. The major focus of the first phase was a series of public "transportation town meetings" that were held throughout the region to solicit community and public input, and meetings with transportation agencies and organizations. These efforts resulted in a large and diverse array of potential improvements, as documented and presented in the Phase 1 report "Initial Study of Suggested Transportation Improvements."

Phase 2 - Consensus on Projects for Further Study

Phase 2 consisted of a preliminary screening of the projects generated in Phase 1 to determine which projects should be carried forward for detailed analysis. The screening was conducted based on:

- consistency with regional and local transportation goals, policies, and objectives.
- consistency with the intent of Intermodal Surface Transportation Efficiency Act (ISTEA) and the Clean Air Act Amendments of 1990.
- the judgments of the PMT Update's "Working Committee," which was comprised of representatives of the Executive Office of Transportation and Construction (EOTC), the Massachusetts Bay Transportation Authority (MBTA), the MBTA Advisory Board, the Massachusetts Highway Department (MHD), the Metropolitan Area Planning Council (MAPC), the Executive Office of Communities and Development (EOCD), and the Central Transportation Planning Staff (CTPS).

Regional transportation policies, transportation system changes since the last PMT, and existing conditions were also documented as part of Phase 2 efforts. These subjects, and

the organization of projects for Phase 3 analysis, are presented in the report entitled "Research Themes for the Program for Mass Transportation."

Phase 3 - Analysis of Projects/New PMT

Phase 3, which is documented in this report, consisted of an examination of the projects brought forward from Phase 2 and the setting of priorities to determine the projects to be included in the new PMT. The examination of projects consisted of the determination of projected ridership for each project in 2020[1], operating and capital costs, fare revenue, traffic impacts, and air quality benefits. Each project was then evaluated based on a number of measures encompassing ridership, cost-effectiveness, and a number of financial, air quality, and other impacts. This Phase 3 report represents the new PMT. It includes all of the new projects that are recommended to be pursued as part of the new PMT. Documentation of the Phase 3 analysis for all projects is included in appendices.

Subsequent Revisions to the PMT

As discussed in the next section and in subsequent chapters, the PMT is one of a number of planning efforts that are now underway. In many cases, these other studies will provide information beyond that which was available at the time this PMT was prepared. Also, new projects, beyond those examined in this effort, may be proposed before the next full update of the PMT.[2] To provide for these situations, it is important that an amendment process be provided that would allow revisions to the PMT in intervening years between full updates. The 1978 PMT was recently amended to include the South Boston Piers Transitway. A similar procedure for future amendments is recommended below.

Amendment Procedure

An amendment procedure is necessary in order that this PMT continue to serve the transit needs of the region. The procedure adopted here is consistent with and derives from the process used in the adoption of the South Boston Piers Transitway amendment. The following procedure is therefore adopted, consistent with Massachusetts General Laws Chapter 161A, Sections 3(k) and 5(g).

Phase 1: Amendment Preparation

Proposed amendment is prepared by EOTC in consultation with statutorily designated agencies as required by M.G.L. Ch. 161A § 5(g) and in consultation and cooperation with the MBTA.

Phase 2: Agency Review

Amendment is submitted to designated agencies to afford a minimum of 30 days (or more at EOTC's option) for review and comment. If no comments are submitted to

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[1]Note that through most of the PMT process, ridership estimates were produced for 2010. To provide for consistency with Regional and State Transportation plans, these estimates have been updated to reflect MAPC and CTPS projections of population, employment, and travel for 2020.

[2]Two current examples of studies that could result in new projects are the MBTA's North Shore Transportation Study, which is examining a variety of Blue Line and commuter rail alternatives for the North Shore, and the MBTA's Crosstown Transit Feasibility Study, which is examining improved crosstown bus services in Boston and Cambridge.

EOTC within 30 days by an agency, that agency will be considered to have no objection to the amendment as submitted.

Phase 3: EOTC Revision

EOTC reviews and evaluates all comments and recommendations. The Secretary, based upon that review and evaluation, makes additions, deletions, or modifications to the amendment as deemed appropriate.

Phase 4: Advisory Board Approval

The Secretary submits the amendment to the MBTA Advisory Board with his recommendation that it be approved. The Secretary may include with the submission a summary of comments which were received and a statement of the extent to which the comments are or are not reflected in the final proposed amendment. The Advisory Board accepts or rejects the amendment in accordance with voting procedures contained in M.G.L. Ch. 161A.

Relationship to Other Planning Efforts

The development of the new PMT has occurred concurrently with the implementation of the integrated planning required by ISTEA. The PMT is therefore one of a number of efforts directed at improving the transportation system. Other related efforts include the development of new regional and state Transportation Plans, the State Implementation Plan (SIP) for the Clean Air Act, and ISTEA management plans (for congestion management, public transportation, and intermodal facilities).

State Implementation Plan

Massachusetts must prepare a new SIP by November 15, 1993 that outlines the steps that will be taken to improve air quality. PMT projects with significant air quality benefits may be included in the new SIP. By including projects in the SIP, the Commonwealth will be making a commitment to the Federal government to implement those projects. Subsequent changes could only be made to substitute projects with the same or greater air quality benefits.

Regional Transportation Plans

The Intermodal Surface Transportation Efficiency Act (ISTEA) requires Regional Transportation Plans to be updated by October 1, 1993. These plans are intended to present a vision of practical and affordable sets of transportation programs and projects for each region through 2020. The MBTA operates largely within the Boston MPO area, but some of its services extend to other regions. Therefore, the PMT was developed in consultation with other Regional Planning Associations (RPAs), as well as with the Boston Metropolitan Planning Organization. It is expected that a number of MBTA projects will be included the Transportation Plans of each of these regions.

State Transportation Plan

Once each region has updated its Regional Transportation Plan, EOTC will create the State Transportation Plan. The State Transportation Plan, which is required by ISTEA and must be produced by January 1, 1995, will be based on the regional transportation plans and will reflect the state's priorities.

ISTEA Management Plans

ISTEA requires the implementation of six transportation management systems, three of which have particular implications for transit. These are:

- **Traffic Congestion Management System (CMS)** to identify areas where congestion occurs or may occur, identify the causes of congestion, evaluate strategies for managing congestion and enhancing mobility, and develop a plan for implementation of the most effective strategies.

- **Public Transportation Facilities and Equipment System (PTMS)** for managing public transportation facilities and equipment, the primary goal of which is to ensure the preservation of current capital facilities and equipment in a good state of repair.

- **Intermodal Transportation Facilities and Systems (IMS)** that identifies intermodal facilities and efficiency measures that consider connections, choices, coordination, and cooperation. The IMS is intended to address the movement of both people and goods.

Management systems must be in operation by January 1, 1995. The region's transportation agencies are now beginning to develop these systems. It is anticipated that PMT projects will play a role in the development and planning of these systems. Likewise, the PMT will be updated to reflect the development of the management systems.

Lastly, a number of new mass transportation services and facility upgrades are mandated by the Americans with Disabilities Act (ADA) of 1990 and by Massachusetts environmental agencies for mitigation of Central Artery/Third Harbor Tunnel construction. These requirements have been addressed throughout the PMT process and in the new PMT.

Chapter 2
What's Different Now

Much of the past planning for public transportation focused on expansion; this emphasis reflected the rapid population and employment growth that occurred in the 1970s. In the 1980s, population growth slowed, but employment and travel continued to grow as a greater proportion of residents entered the workforce. Often, growth occurred so quickly that new demand outpaced expansion of transit and highway capacity.

Now, growth in both population and employment has slowed, and for the foreseeable future, MAPC projects that the region's population and employment will grow at much more moderate rates than in the past (up 1.7 percent and 15.4 percent, respectively between 1990 and 2020). A more stable environment provides an opportunity to catch up and to better plan for the future.

Also, funding is more constrained now than it was in the past. The MBTA's four major sources of funding—fares, local assessments, the Federal Transit Administration (FTA), and the state—are all constrained. Ridership is sensitive to fares, so that they must be kept at reasonable levels. Federal operating assistance has not increased since 1985. Increases in district assessments have been capped at 2.5 percent per year since the passage of "Proposition $2^1/2$" in 1978. As a result, it has been necessary for the state to fund much larger proportions of the MBTA operating deficit than in the past. In addition, the federal share of capital costs has declined over the last decade, increasing the state's share of those costs as well. Because of limitations in state resources, state funding of the capital program has been capped at approximately $300 million per year through FY 1997.

There are also now a number of federal and state mandates for new MBTA services. These include:

- The Americans with Disabilities Act (ADA) which, among other things, requires that the MBTA system be made accessible. The estimated cost for ADA compliance is $588 million, not including additional costs built into ongoing projects and future expansion. When these costs are included, the total is estimated to be close to $1 billion.

- The Clean Air Act, which requires that regional emissions be reduced by 15 percent between 1990 and 1996, and by three percent per year between 1996 and 1999. The state must commit to specific projects that will be undertaken to attain these reductions in its State Implementation Plan (SIP). A large number of the projects that are in the current SIP and/or that have been forwarded to the EPA as proposed SIP amendments are MBTA projects.

- Service improvements to mitigate construction impacts required by the state Department of Environmental Protection (DEP) as part of its approval of the Central Artery/Tunnel (CA/T) project. (Many of these are the same projects that are in the SIP.) The estimated cost of MBTA projects that are in the current SIP, that have been forwarded to the EPA as proposed SIP amendments, and/or are required to mitigate CA/T construction is approximately $2.1 billion.

Americans with Disabilities Act (ADA)

The Americans with Disability Act (ADA), enacted on July 26, 1990, provides comprehensive civil rights protections to individuals with disabilities in the areas of employment, public accommodations, state and local government services, and telecommunications. Its stated purpose is:

- "to provide a clear and comprehensive national mandate for the elimination of discrimination against individuals with disabilities;
- "to provide clear, strong, consistent, enforceable standards addressing discrimination against individuals with disabilities;
- "to ensure that the Federal Government plays a central role in enforcing the standards established in the Act on behalf of individuals with disabilities; and
- "to invoke the sweep of congressional authority...to address the major areas of discrimination faced day-to-day by people with disabilities."

Federal regulations (49 CFR Part 37 - Transportation Services for Individuals with Disabilities) implement the public transportation provisions of Title II and Title III of the ADA. In brief, the requirements that pertain to the MBTA are listed below:

- Newly constructed state and local government buildings, including transit facilities, must be accessible.
- When alterations could affect accessibility to "primary function" areas of a transit facility, an accessible path of travel must be provided to the altered areas and the restrooms, drinking fountains, and telephones serving the altered areas must also be accessible, to the extent that additional accessibility costs are not disproportionate to the overall alteration costs.
- New buses and rail vehicles for fixed route systems must be accessible.
- New vehicles for demand responsive systems must be accessible unless the system provides individuals with disabilities a level of service equivalent to that provided to the general public.
- One car per train must be accessible by July 26, 1995.
- Existing "key stations" in rapid rail, commuter rail, and light rail systems must be accessible by July 26, 1993. Extensions may be granted up to July 26, 2010 for commuter rail and July 26, 2020 for rapid and light rail stations needing extraordinarily expensive structural changes.
- Comparable paratransit must be provided to individuals who cannot use fixed route service.

- New buses and other vehicles (except automobiles) operated by private entities must be accessible or the system in which the vehicles are used must provide individuals with disabilities a level of service equivalent to that provided to the general public depending on whether the entity is primarily engaged in the business of transportation; whether the system is fixed route or demand responsive; and the vehicle seating capacity.

- After July 26, 1996, new over-the-road buses (buses with an elevated passenger deck located over a baggage compartment) must be accessible.

The MBTA has submitted its Key Stations Plan to the Federal Transit Administration (FTA). This plan includes improvements necessary to make 27 rapid transit, 22 commuter rail, and 27 light rail stations accessible. The cost of this plan over the next five years will be approximately $43 million. The full cost of making all stations accessible will be approximately $243 million over a 20 year period. Ultimately, the operating and capital cost of meeting ADA requirements is estimated by the MBTA to be as high as $1 billion over the next 20 years. This includes the cost of procuring all new vehicles for the Green Line, the added cost of lift-equipped buses, and ADA-related expenses for new services.

Central Artery Mitigation/Clean Air Act

The dominant transportation project for the Boston region for the remainder of the 1990s and into the beginning of the next century will be the construction of the new Central Artery and the third harbor tunnel. During construction of this project, a number of mitigation measures must be taken to encourage travelers to utilize transit. In December 1991, the Massachusetts Department of Environmental Protection (DEP) approved a set of regulations that required the MBTA to undertake a number of transit system projects to help mitigate CA/T construction.

In addition, the Clean Air Act requires that regional emissions be reduced by 15 percent between 1990 and 1996, and by three percent per year between 1996 and 1999. The Commonwealth's plans for improving air quality in compliance with the Clean Air Act are documented in the State Implementation Plan (SIP). The current SIP, and proposed amendments, include a number of MBTA projects; this SIP must be updated by November 15, 1993. The SIP allows EOTC to substitute other transit improvement projects in place of those listed in DEP regulations. To replace a project, EOTC must demonstrate to the DEP that a specific project is not feasible due to adverse engineering, environmental or economic impacts. An alternative project may be substituted if it achieves equal or greater emission reductions.

Capital and capital-related MBTA projects that are included in the SIP or required by DEP regulation are as listed in Table 2-1. As indicated in this table, many of these projects have either been completed or are underway. Projects that have not yet begun, along with projected ridership, VMT, and air quality impacts are shown in Table 2-2. Most of these projects involve new services, the expansion of parking along existing services, or maintenance of the system.

As discussed in detail in Chapters 5 and 8, nearly all of the SIP and CA/T service improvement projects have merit in terms of new ridership, reduction in vehicle miles of travel (VMT), cost-effectiveness, and air quality benefits. With the possible exception of four projects—Green Line Arborway restoration, 400 buses, the Newburyport commuter rail extension, and two commuter boat facilities—and assuming that sufficient funding is

Table 2-1
Transit-Related SIP and CA/T Mitigation Projects

Project	SIP	CA/T Mitigation
Old Colony Commuter Rail Restoration (underway)	√	√
Newburyport Commuter Rail Extension	√	√
Worcester Commuter Rail Extension	√	√
Lynn Station and Garage (completed)	√	
North Station High Platforms (completed)	√	
South Station Track 12	√	
North Station - South Station Link Study (completed)	√	
South Station Access to Red Line (completed)	√	
Blue Line - Red Line Connector	√	√
Blue Line Station Modernization	√	√
Green Line Extension to Tufts	√	√
Green Line Arborway Restoration	√	
Andrew Station Access (underway)		√
New Red Line Vehicles (underway)		√
New Orange Line Vehicles		√
South Station Bus Terminal (underway)	√	√
South Boston Piers Transitway	√	√
Washington Street Replacement Service		√
Circumferential Bus Study (underway)	√	√
400 New Buses		√
10,000 Additional Parking Spaces by 12/31/96	√	√
10,000 Additional Parking Spaces by 12/31/99	√	√
2 Commuter Boat Facilities (Fort Point Channel)		√

available, all are worthy of implementation with timeframes consistent with SIP and CA/T mitigation requirements.[1] EOTC, the MBTA, and the CA/T Project are now addressing funding issues related to SIP and CA/T Mitigation projects. Substitutes for SIP and CA/T Mitigation projects are not recommended at this time, but based on the outcome of these discussions, some substitutions may be necessary or desirable.

The estimated cost of the SIP and CA/T Mitigation projects that have not yet been implemented will be approximately $2.1 billion (see Table 2-2). With substitutions, costs would be somewhat lower. These projects are described in detail in Chapters 6 and 8.

[1]While a substitution for Arborway restoration for SIP purposes may be advisable, improved service in this corridor (restoration or replacement) should continue to be pursued. See Chapter 8 for additional information.

Table 2-2
Capital Cost, Ridership, and Air Quality Impacts of SIP and CA/T Mitigation Projects Yet to be Implemented

Project	SIP	CA/T	Capital Cost	2020 Total Weekday Ridership	% Reduction in Regional Emissions
Old Colony CR Restoration	√	√	$560.0m	23,200	0.37%
Newburyport CR Extension	√	√	$41.0m	1,600	0.04%
Worcester CR Extension	√	√	$119.0m	6,700	0.10%
Blue Line - Red Line Connector	√	√	$137.5m	19,200	0.05%
Blue Line Station Modernization	√	√	$361.9m	NA	NA
Green Line Extension to Tufts	√	√	$88.0m	11,600	0.06%
Green Line Arborway Restoration	√		$56.6m	36,000	<0.01%
New Orange Line Vehicles		√	$131.0m	NA	NA
South Boston Piers Transitway	√	√	$355.9m	35,100	0.05%
Washington Street Replacement Service		√	$40.0m	10,200	<0.01%
400 New Buses		√	$88.0m	NA	NA
10,000 Add'l Parking Spaces by 12/31/96	√	√	$0.0m[2]		
10,000 Add'l Parking Spaces by 12/31/99	√	√	$107.0m		
2 Commuter Boat Facilities		√	TBD	4,600	≤0.01%
Total			$2,085.9m	148,200	≈0.68%

[2]The commitment to add 10,000 spaces by 1996 can be met through a combination of spaces recently completed (1,650), and parking at new stations on the Middleborough and Plymouth Old Colony lines (6,630) and the Worcester extension (2,500). The costs for these spaces are included within the costs of Old Colony and Worcester extension projects.

Chapter 3
Regional Commuting Patterns

The region's transit needs are based on a number of factors. The most important of these are current and future travel patterns, development characteristics, and travel volumes between major origins and destinations. This chapter describes current travel patterns; the following chapter describes the role that transit can effectively fill with the context of current travel patterns and projected growth.

Overview of Regional Work Trip Travel

On a typical weekday, over 1,420,000 work trips are made within the Boston region, and another 300,000 trips are made between the region and other parts of Massachusetts, New Hampshire, Maine, Vermont, Rhode Island, and Connecticut.[1] Of these trips, 607,000 are made to the urban core of Boston and Cambridge, 522,000 are made to the 30 communities along Route 128, and 593,000 are made to other suburban locations.

These numbers represent large increases over the past two decades: 31 percent since 1970 within the region, and more than 300 percent from outside of the region. Since 1980, work trips within the region have increased 8 percent while trips from outside of the region have increased almost 200 percent. While the number of trips to Boston and Cambridge have increased since 1980 (by 9.8 percent) and these cities remain the focal point of the region, the number of trips to the suburbs has increased at a much faster rate (up 21.9 percent). As the number of jobs has been increasing, the length of work trips has also been increasing. Thus, the number of miles traveled, and congestion, has increased by an even greater extent. Between 1980 and 1990, the average work trip length in eastern Massachusetts increased from 22.8 minutes to 24.1 minutes. Over the same period, vehicle miles of travel (VMT) for all trip purposes in the Boston urbanized area increased from 41.4 million to 51.3 million per day, a 24% increase.[2]

There are several explanations for these trends. Housing prices rose steeply in the 1980s, and the continued desire for suburban housing forced many residents to move outside of I-495. At the same time, it became easier to commute longer distances by automobile: fuel prices, when measured in constant dollars, have been declining, cars have become less costly

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[1]Figures are from the 1990 US Census. For these purposes, the Boston region is considered to be the same as the MAPC region.

[2]VMT figures from the Bureau of Transportation Planning and Development.

to maintain, and expressway construction in the 1960s and 1970s made it possible to travel longer distances in less time.

Most of the transit system is focused on the core. As jobs in the core grew, the existing transit system was upgraded and expanded. As people moved farther out, the commuter rail system was rebuilt and expanded. The result of these improvements has been that transit ridership increased during the 1980s, and that transit maintained its share of the core work trip market (31.6 percent in 1990 versus 31.9 percent in 1980).

In the suburbs, increases in travel have been accommodated largely with increases in the use of private automobiles (88.8 percent of all suburban work trips). This is because suburban development is typically not conducive to traditional transit service:

(1) Development densities are low, which means that long walks are often required.

(2) The volumes of travel between any two given points are lower than to the core. The low volumes mean that high levels of service cannot be supported. This, in turn, makes transit inconvenient.

(3) Because of free parking, transit is often perceived as more expensive than automobile travel.

Given the difficulties in serving suburban travel with transit, significant expansion of transit to serve this market has not been attempted. Instead, expansion has been focused on the urban core market, which transit can serve most effectively.

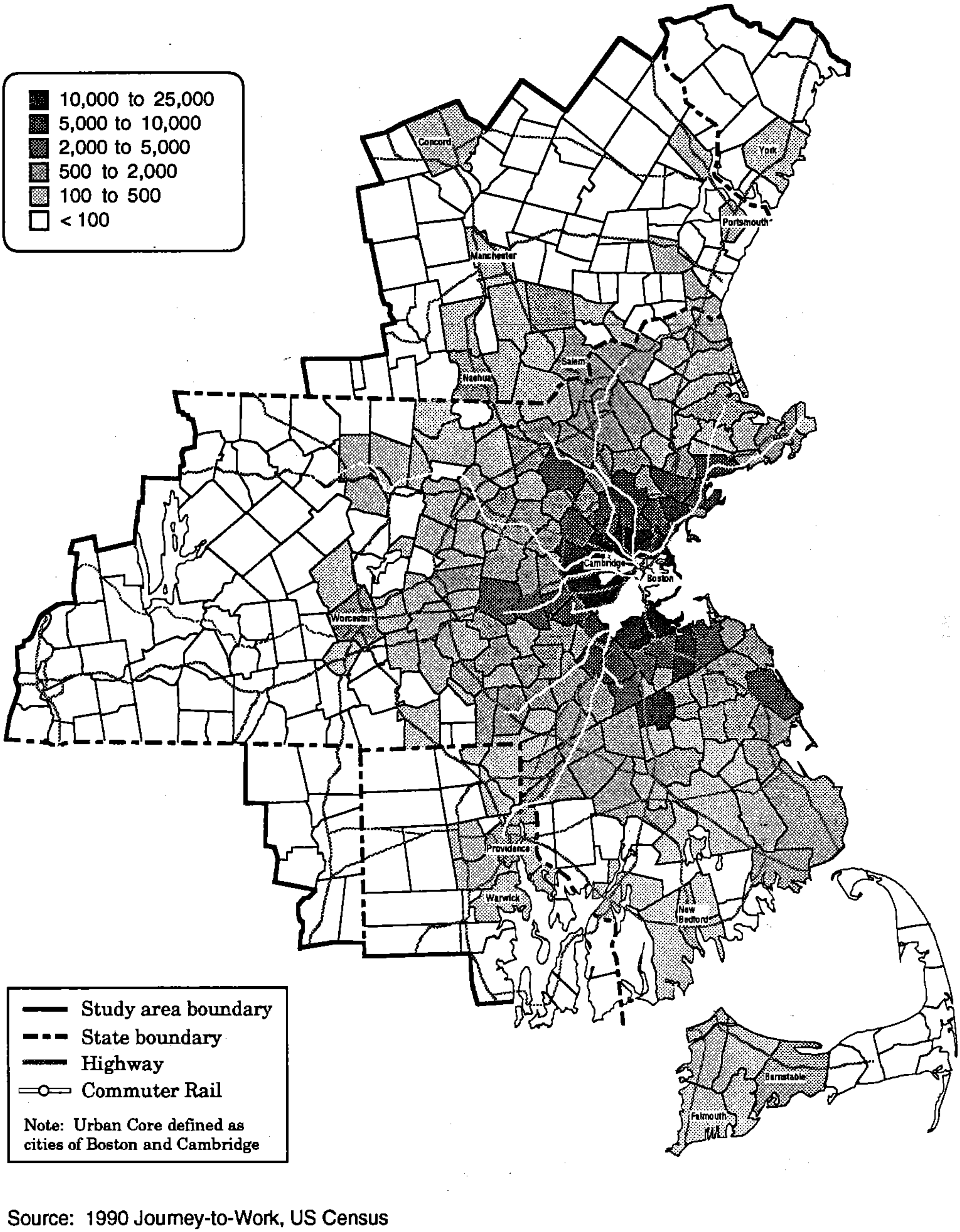
Work Trips to Boston and Cambridge

Each weekday, 607,000 work trips are made to Boston and Cambridge. This represents 35.3 percent of all work trips made within the region. Of these, 341,600 (57.7 percent) are made by automobile, 187,200 (31.6 percent) are made by transit, 53,900 (9.1 percent) are made by walking, and 9,100 (1.5 percent) are made by other modes.

As would be expected, the number of trips to and from Boston declines with distance. However, large numbers of trips are made from long distances. Figure 3-1[3] shows the number of commuters to the "urban core" of Boston and Cambridge. Over 240,000 urban core workers live in the urban core. Communities immediately surrounding Boston and Cambridge send in large numbers of workers—190,320 from the 28 other communities within Route 128. Between Route 128 and I-495, the numbers are smaller but the slow rate at which they diminish demonstrates the strength and extent of the influence of Boston and Cambridge. Communities from beyond I-495 such as Nashua, Manchester and Salem, New Hampshire, Worcester, Providence, New Bedford, and Barnstable each have more than 500 residents that commute to the urban core. Over 100 people commute from Falmouth, Warwick, Rhode Island, Concord and Portsmouth, New Hampshire and York, Maine. Note that the number of commuters to the urban core is closely correlated with transportation

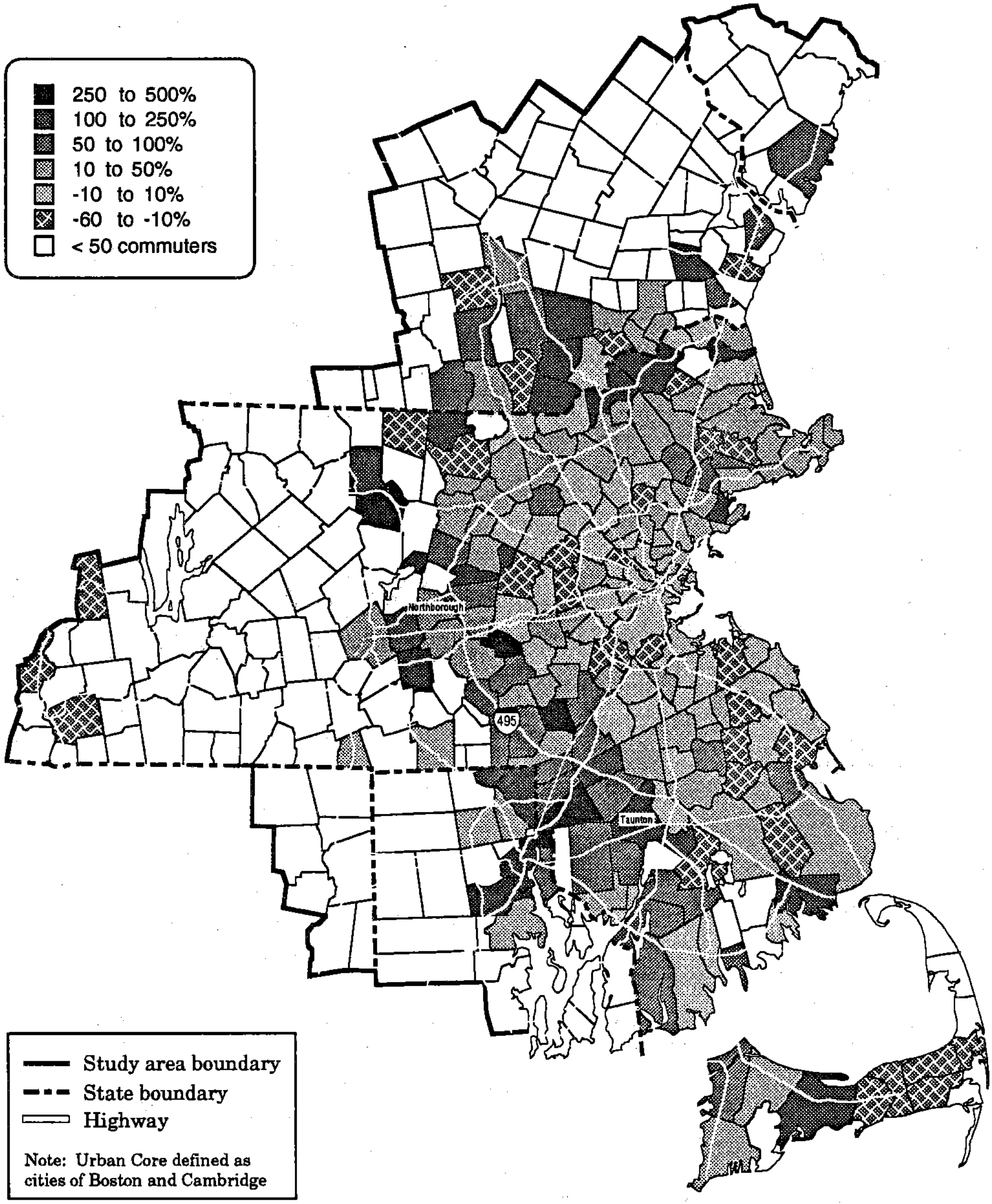
[3]Figure 3-1, and subsequent figures in this chapter, display trips made from 388 cities and towns in five of the six New England states. This 388-community region extends to roughly a sixty-five mile radius around downtown Boston and encompasses several metropolitan areas: Worcester, Providence, Fall River, New Bedford, Brockton, Lowell, Lawrence, Haverhill, Fitchburg, and Manchester, Nashua, Concord and Portsmouth New Hampshire, among others. This area is home to approximately 7.5 million people.

Figure 3-1
Number of Commuters to the Urban Core: 1990



Source: 1990 Journey-to-Work, US Census

Figure 3-2
Percent Change in Number of Commuters to the Urban Core: 1980-1990



Source: 1980, 1990 Journey-to-Work, US Census

access to the core. All of the communities with the highest number of Boston and Cambridge workers are located on a major expressway and/or transit line.

Work trips have lengthened as the influence of Boston and Cambridge has expanded. Between 1980 and 1990, most of the close-in communities showed little change in the number of trips to the core (i.e. less than 10 percent change up or down), while some experienced a significant decline (see Figure 3-2). Most of the rapid growth in the number of commuters to the urban core over the last decade occurred along the I-495 ring and beyond, with several communities in this region experienced a doubling or even a three and four-fold increase in commuters to Boston and Cambridge. The area with the largest growth was along the southwestern stretch of I-495 between Ashland and Taunton. In addition, there were rapid increases in other areas such as parts of southern New Hampshire and Cape Cod.

Since 1980, most of the growth in travel has been in single occupant vehicles (SOVs). As shown in Figure 3-3, most cities and towns experienced an increase in the SOV mode share of between five and 25 points. A few towns to the west, from Westborough to Westford, had larger shifts toward SOVs of up to 50 percent. Although there are a few scattered communities which saw the percentage of commuters driving alone drop during the 1980s, the only portion of the region where this happened with any consistency was in the southwest, around Ashland, Bellingham and Wrentham.

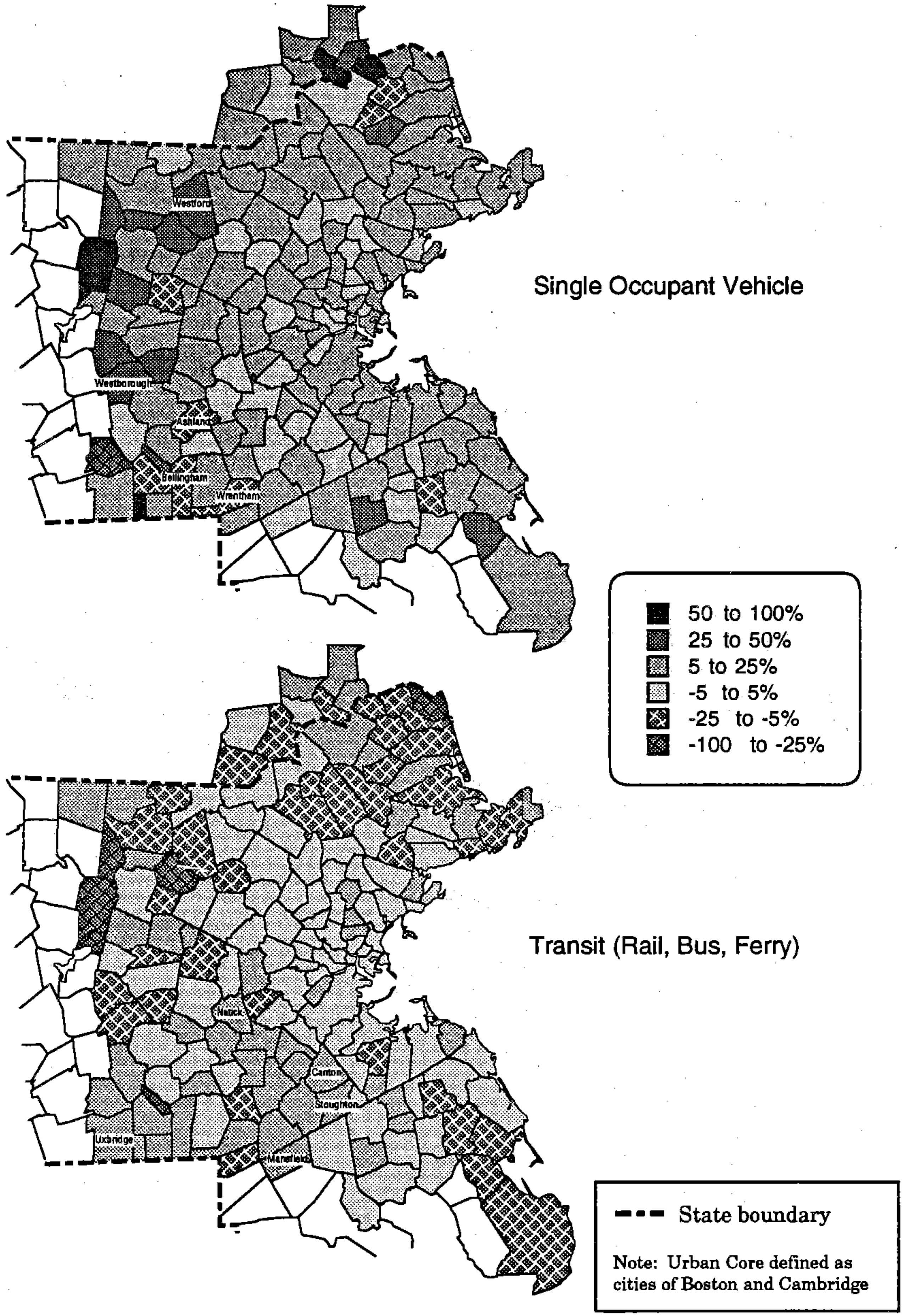
While the SOV mode share was increasing, most areas had a stable or moderately declining transit mode share. The major exception was to the southwest of Boston in an area stretching from Canton and Stoughton, up to Natick, down to Mansfield, and out to Uxbridge. These communities had the percentage of their commuters to the urban core using transit rise by 5 to 25 percent. Most of this increase occurred on commuter rail, which can be explained by improvements to the Franklin and Attleboro lines made during the 1980s, including new equipment, the improved Southwest Corridor, and the opening of a large park and ride facility at Forge Park/I-495 station.

In other parts of the region, most of the decrease in transit mode share is due to declining bus ridership. This decline may be somewhat overstated because bus ridership may have been artificially high in 1980 as a result of the 1979 oil crisis. Note also that declining or stable transit *mode share* does not imply declining or stable *ridership*. With the increase in urban core employment and its corollary increase in the number of commuters to the urban core, a stable, or even slightly declining mode share could represent an increase in the number of riders, albeit a small increase relative to the increases in other modes. (For example, while the transit mode share declined by 0.3 percent between 1980 and 1990, MBTA ridership increased by nearly 20 percent between 1983 and 1993.)

Today, the cities and towns immediately surrounding the core generally have the highest transit shares, generally ranging between 35 and 50 percent (see Figure 3-4). This is as would be expected, given the high level of transit service provided by the local and express buses and subway lines. However, many distant communities—for example, Providence, R.I., Attleboro, and Mansfield, as well as others distributed along the edge of the study area—have higher transit shares than close-in communities, reflecting strong patronage of private bus companies and commuter rail.

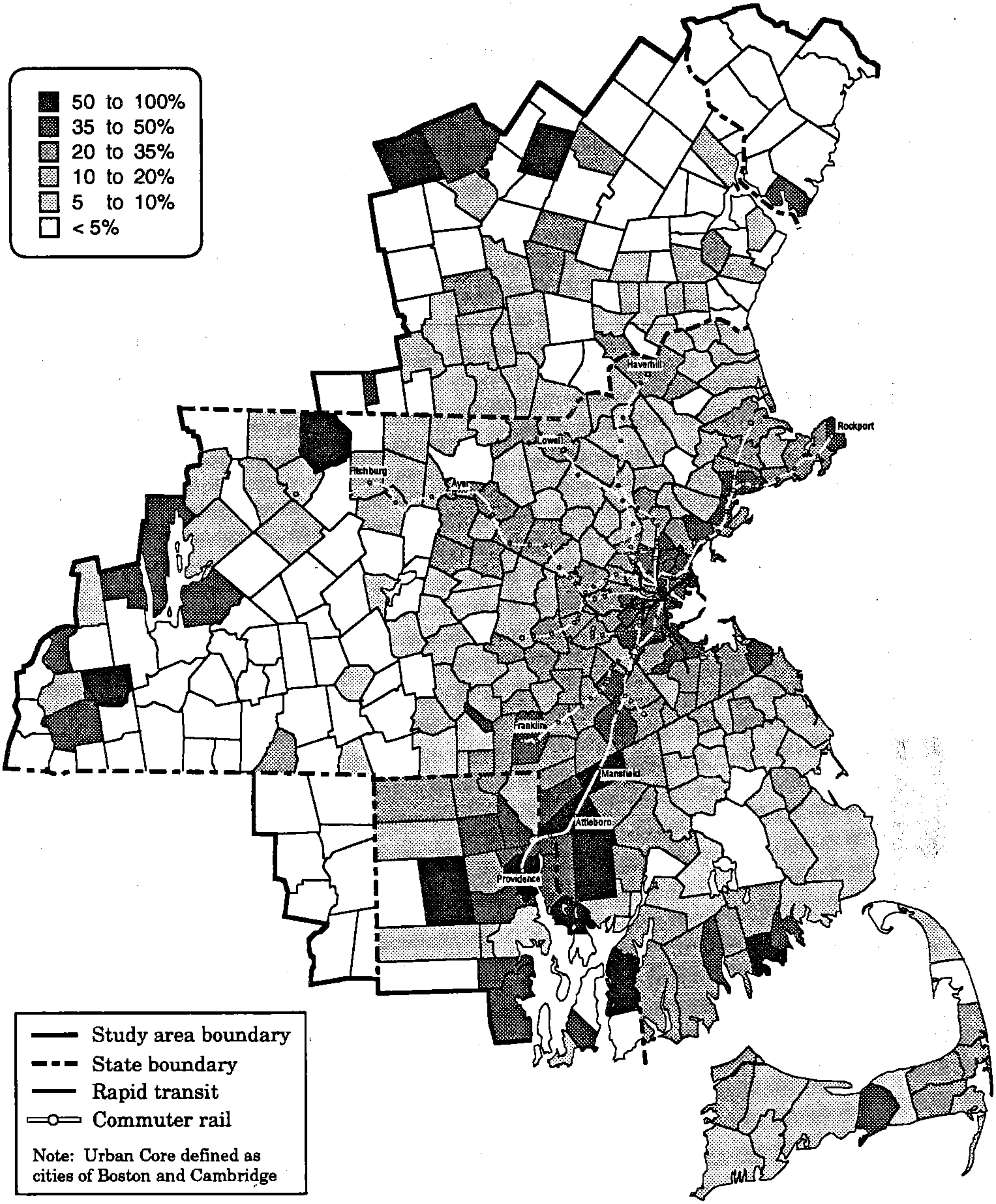
The particular effect of commuter rail service can also be clearly seen in Figure 3-4, notably on the North Shore up to Rockport and to the southwest along the Franklin and Attleboro/Stoughton lines. In these two corridors, commuter rail offers travel times comparable to automobile travel times, mainly because I-95 from Canton through Boston and up to Peabody was never built. On the Haverhill and Lowell lines, the terminal cities have high transit shares (20 to 35 percent) while intermediate communities generally have lower

Figure 3-3
Changes in Mode Share to the Urban Core: 1980-1990



Source: 1980, 1990 Journey-to-Work, US Census

Figure 3-4
Percentage of Commuters to the Urban Core Who Use Transit: 1990



Source: 1990 Journey-to-Work, US Census

shares of between 10 and 20 percent. On the Fitchburg line, all of the communities past Ayer have low shares, reflecting the relatively low ridership on that segment of the system.

Work Trips in and to the Suburbs

While the largest proportion of the transit ridership is to and from the core, 65 percent of all work trips (1,115,000 of 1,722,000 work trips) are made to locations outside of the core. Much of this employment is located in suburban job centers along Route 128 and in other satellite cities (see Figure 3-5). Growth in employment in these areas has resulted in a much greater dispersion of jobs than existed in either 1970 or 1980.

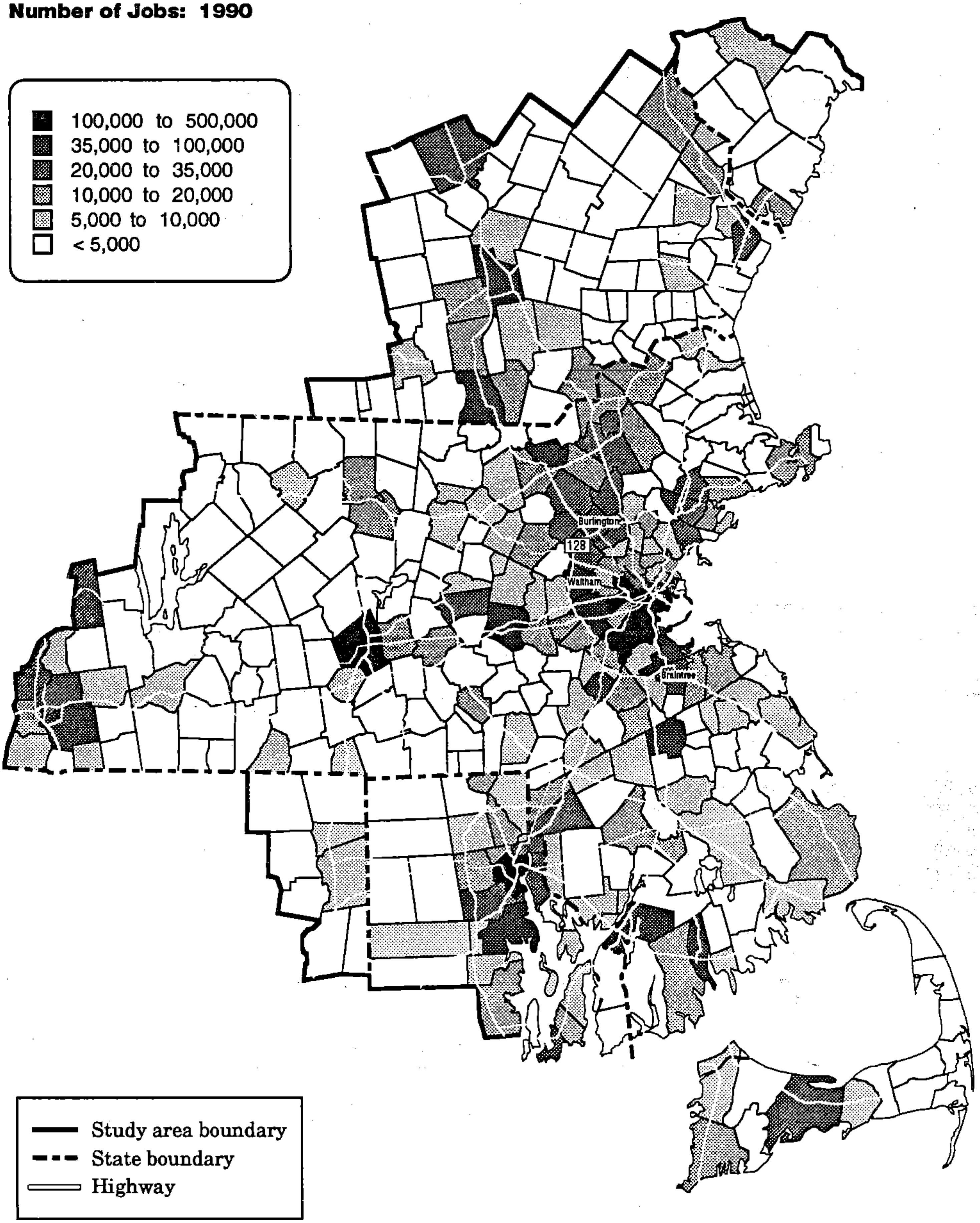
Suburban communities along Route 128 draw employees from a wide area in much the same manner as the core, but in lower volumes. These characteristics point out the basic problem in providing attractive transit services to and from these areas: although the geographical extent of the need for service is almost as large as for the core, the lower volumes are not sufficient to support frequent service. Three specific examples are Waltham, Burlington, and Braintree, which are large employment centers along Route 128.

Waltham, which is the largest of the three, and the largest employment center on Route 128, has less than one-tenth the employment of the urban core (57,000 versus 607,000). However, as shown in Figure 3-6, Waltham employees travel from distances nearly as long as those to Boston and Cambridge, with commuters coming from as far away as Manchester, New Hampshire, Charlton and Plymouth, Massachusetts, and Warwick, Rhode Island. Cities and towns sending more than 100 commuters to Waltham are not quite as spread out, extending to Haverhill, Nashua, Worcester, Attleboro and New Bedford. Waltham has a significant amount of transit service: five local MBTA bus routes, one express MBTA bus route, and commuter rail. However, these services are oriented around downtown Waltham and toward core area commuting, and do not serve Route 128 employment centers. The design of these services reflects existing travel volumes: while 5,440 Waltham residents commute each day to the core (1,190 on transit—a 22 percent share), no more than 4,600 (from Boston) travel to Waltham from any single community.[4] Of all 57,000 commuters to Waltham, only 1,200 (2 percent) used transit.

Burlington is smaller than Waltham, but faster growing. Its 1990 employment of 32,000 jobs was just over half that of Waltham, but 9,000 new jobs in the 1980s represented almost a 50 percent increase. Despite its smaller size, Burlington draws commuters from distances as long as Waltham and the urban core. The long distances may be partly explained by the high housing prices of the mid and late 1980s, which forced the people filling the newly created jobs in Burlington to live at the edges of the urban area, far from their workplaces. A particular feature of Burlington is that it imports a huge percentage of its workforce: 88 percent of the workforce lives out of town (compared to 75 percent for Waltham and 64 percent for the urban core). In addition, no single community houses a large concentration of Burlington's workers—medium-size concentrations of 500 to 2,000 are spread over several cities and towns stretching from Boston to Nashua. Burlington is served by three MBTA bus routes, two of which are oriented toward core area commuting, and one of which is oriented toward work trips from Boston to Burlington. (The town also operates a mini-bus service, but this service is not designed to serve work trips and begins operation

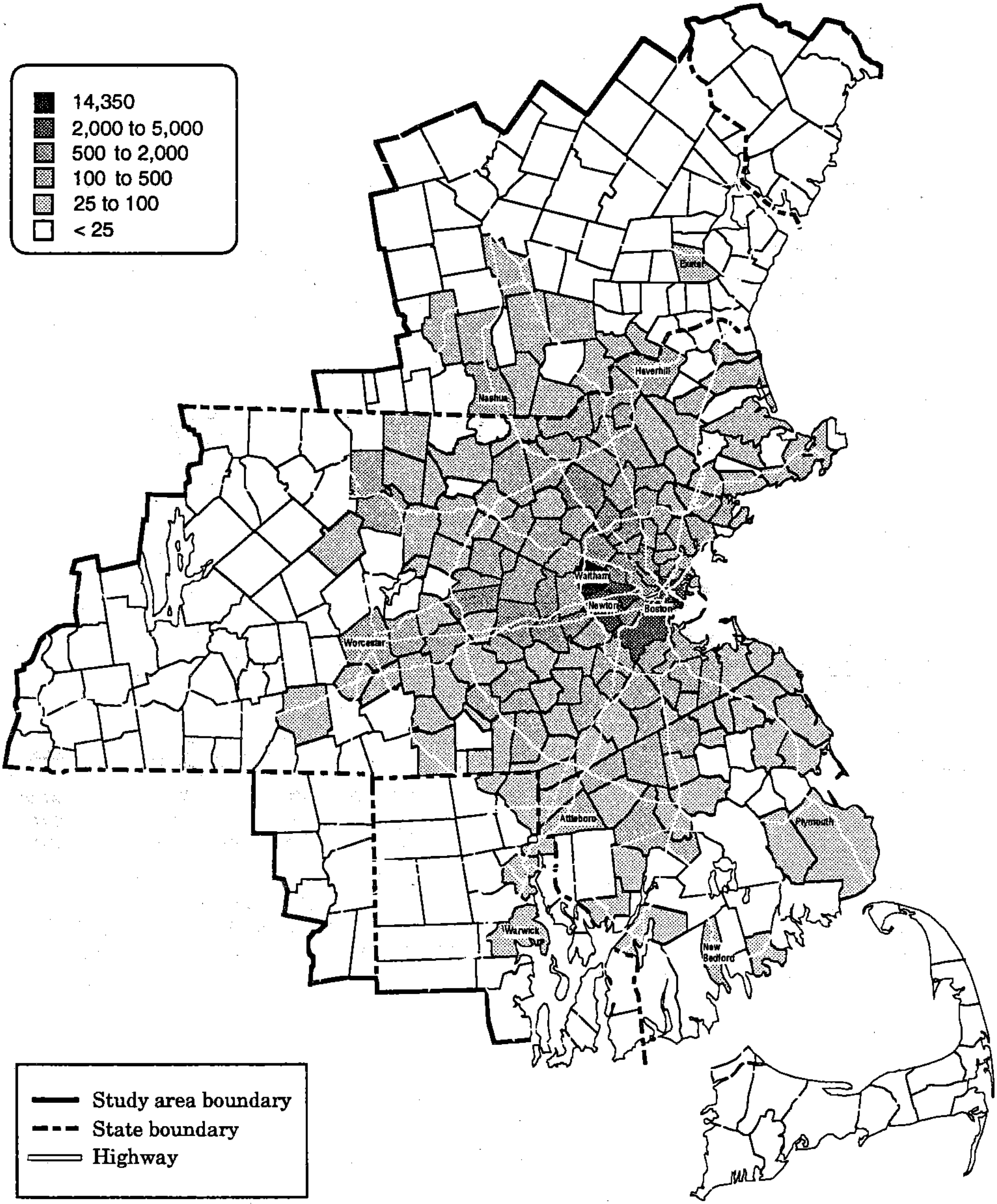
[4]Over 14,000 Waltham residents work in Waltham. After Boston, the next largest source community for Waltham workers is Newton at 2,500. Of Boston's commuters to Waltham 414 used transit(9%).

Figure 3-5
Number of Jobs: 1990



Source: 1990 Journey-to-Work, US Census

Figure 3-6
Number of Commuters to Waltham: 1990



Source: 1990 Journey-to-Work, US Census

after the end of the AM peak.) Only 1.65 percent of the Burlington workforce commutes on transit.

Finally, Braintree, located at the southeastern end of Route 128 at the intersection with Route 3 and the Southeast Expressway, exhibits somewhat different characteristics. It has roughly the same employment as Burlington, with nearly 30,000 jobs, but the extent of its commuter source area is smaller. It imports a large percentage of its workforce–84 percent–but many of the imported workers are concentrated in a few nearby communities including Boston, Quincy and Weymouth. Braintree's commuting pattern is skewed to the south because Route 3 is relatively uncongested south of Braintree, and because it is difficult to drive through Boston from the north. Braintree has transit service, with the Red Line and several bus routes, and will have even more when the Old Colony Line is restored. However, these services are oriented toward core area commutes, and less than four percent of the workforce uses transit to get to work.

Summary/Outlook

While Boston and Cambridge remain the region's largest employment centers, the total number of jobs in the suburbs now exceeds the number in Boston and Cambridge. The high rate of growth in employment in the suburbs means that the region's jobs are now more dispersed than ever before. In addition, the area's residents have been moving farther away from their jobs, which has increased travel to a greater extent than the increase in employment.

Transit has retained a high share of the market only in places where it offers service comparable to the automobile. In the urban core, the cost of parking often outweighs a car's travel time advantage. For very long distance trips, an express bus is as fast as a car and can be cheaper, especially considering parking costs. Along certain commuter rail lines to the northeast and southwest, automobile access times are inferior, making transit very attractive.

For commuting to suburban workplaces, transit garners 2 to 4 percent on average. Using transit in the suburbs is typically less convenient than using a car, and with free parking, there is little incentive not to drive. Commuting to suburbs is therefore dominated by automobile trips, rather than the multimodal commuting characteristic of the urban core.

Because of differences between the urban core and the suburbs—differences in the nature of development, the total number of jobs, and the amount of travel—transit will fill different roles for trips to Boston and Cambridge than in the suburbs. These roles, and future strategies for improving transit in the core area and the suburbs based on their respective roles, are discussed in detail in the next chapter.

Chapter 4
The Role of Transit / Future Strategies

Until the 1960s, the Boston area's transportation system was developed in a manner similar to most parts of the United States, with an emphasis on transit until the end of World War II, and then on highway construction to accommodate rapidly increasing levels of automobile travel. Starting in the 1960s, however, the impact of major highway projects on the region's environment and quality of life became more apparent. By 1970, public opposition to further highway construction had grown to the point where then Governor Francis Sargent placed a moratorium on expressway construction within Route 128. This moratorium suspended a number of planned projects including the Inner Belt and I-95 through Boston between Canton and Lynnfield. In 1972, the suspended highway projects were permanently canceled and replaced by an increased emphasis on the expansion and improvement of the region's transit system.

Today, the Boston area is recognized as one of the most attractive in the United States. Part of the reason for this is that the transportation decisions made since 1970 have established a balanced transportation system. Extensive highway and transit systems work together to maintain our environment and a high quality of life while providing for strong economic growth. Compared to other American cities, such as Los Angeles, Denver, and Houston, which are now beginning to plan and/or construct rail systems, the Boston area already has a multimodal transportation system in place. Further, most components of the transit system function as intended and are well utilized. Future challenges consist of maintaining and upgrading the existing system in combination with selected expansions and various improvements to make the individual components of the system work together better.

The complexity of the multimodal transportation system and the variety of the travel options available in the Boston region make it difficult to study the public transportation system in isolation. The Transportation Plan for the Boston Region takes a very broad perspective, examining all modes of transportation in the Boston area. The Statewide Transportation Plan, which will be completed by January, 1995, will take an even broader view, considering how all of the transportation systems in the state are interrelated.

This document focuses on MBTA services. However, it does also address other services used to connect to and from the MBTA, as well as those that could provide an alternative to MBTA expansion. For a full discussion of other modes, refer to the Transportation Plan, available from the Boston Metropolitan Planning Organization.

This chapter describes the context in which the PMT was developed by providing an overview of the role of transit in the MBTA service area, provides strategies to enhance that role, and adopts a mechanism for ongoing changes to this PMT. In the future, increased use of public transit will be needed to:

- Accommodate job growth
- Manage traffic congestion
- Provide better travel options
- Make more land available in the core area for more productive uses
- Improve air quality
- Reduce energy consumption

Accommodating Job Growth in the Core Area
An increase in transit capacity will be necessary to accommodate future job growth in the core area. At the present time, all major highways and most rail services to downtown Boston are at or near capacity during peak periods. Between now and 2020, the Metropolitan Area Planning Council (MAPC) projects that employment in the core area of Boston and Cambridge will increase by 7.1 percent.[1] The Central Artery/Third Harbor Tunnel project will remove a major bottleneck and increase capacity, but radial highway capacity to the core will continue to be limited. Planned management systems should improve the operation of the highway system and may increase effective capacity, but large-scale lane additions for single-occupancy vehicles are unlikely. Therefore, most of the new trips to the core area will need to be carried on transit and other forms of high occupancy transport such as vanpools and carpools.

Managing Traffic Congestion
The state and the region are now developing congestion and incident management plans in order to manage traffic congestion. The transit system is crucially important in reducing the burden on the highway system and will continue to play that role in the future. Congestion management will seek to make different components of the transportation system work better together, emphasizing facilities and programs that encourage higher occupancy travel, such as transit and ridesharing.

Providing Better Travel Options
ISTEA emphasizes the provision of multiple travel options. No single mode can satisfy a region's wide range of mobility needs. Transit offers an alternative which, for some areas, may be lower cost or more convenient. Expanding service in areas that can be served effectively by transit will allow people to choose the most efficient means of travel. In addition many people cannot drive a car due to age or disability, or do not have a car available. For these people, transit service is essential for mobility.

Making Land Available for Other Uses
Public transit facilities require significantly less land than facilities for automobiles. An increased use of public transit can make more land available for housing, commerce, and recreation. A reduction in the need to accommodate cars also makes it possible to design street spaces at a more human scale, improving the pedestrian environment and making the region more "livable."

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[1]Forecasts by the Metropolitan Data Center of the Metropolitan Area Planning Council, based on the Massachusetts Department of Employment and Training Employment and Wage Program and Current Employment Statistics.

Improving Air Quality

The Clean Air Act requires that regional emissions be reduced by 15 percent between 1990 and 1996, and by three percent per year between 1996 and 1999. Transit system enhancement will play a significant role in the region's effort to clean the air. Increased use of public transit results in cleaner air by shifting travelers out of single-occupancy automobiles. Also, mass transportation facilities can encourage a higher density of development, especially along major transit corridors. This, in turn, can lead to more trips made by transit and walking, which improves air quality, and reduces traffic congestion and energy consumption.

Reducing Energy Consumption

When transit is operated effectively and is well utilized, it can transport people with greater energy efficiency than automobiles. While there are no shortages of gasoline at this time and none are expected in the short-term, it is prudent to make our energy resources last as long as possible.

The Role of Transit in Eastern Massachusetts

With few exceptions, the geographical extent of the existing mass transportation system and the levels of service provided are directly related to the density of development, both commercial and residential. The higher the number of residents and jobs in an area, the more trips that are made, and where large numbers of trips are made, high levels of transit service can be supported. This makes transit attractive by making it convenient. This is especially true in Boston, Cambridge and Somerville, where high densities of both population and employment result in high volumes of trips within a small area; the high volumes of travel support a high level of transit service. In the suburbs within and beyond Route 128, population densities are lower and fewer trips are made to and from any given location. The lower trip volumes to and from these areas cannot support the same level of transit service as the core area.

Most travelers can be grouped into four categories. These consist of people who:

(1) can choose between a private automobile and transit.
(2) must use an automobile or truck for work or other reasons.
(3) must use an automobile because transit is not available.
(4) must use transit because of age, disability, or other reasons.

The potential market for transit consists of categories (1), (3), and (4). Where transit is not available, service can be expanded to attract new riders from among those that are not now served. Once transit is available, it must then attract those persons that have an automobile available for their trip on the basis of cost, convenience, and travel time. Automobile travel is usually more convenient and faster than transit travel, so the trade-off usually becomes one of whether the additional convenience and the travel time savings of driving are worth the cost.

For trips to downtown Boston and other core areas, transit is very attractive because the parking costs are high, and the convenience and travel time are often comparable to automobile travel. The combination of a high market share and a large market results in a high demand for service. The high demand, in turn, means that there will be enough people to fill the frequent buses and trains which make up a high level of service. The frequent service makes transit more convenient which reinforces the high demand, and so forth.

For trips in or to the suburbs, out-of-pocket automobile costs are low because parking is free (or inexpensive), and the convenience and time savings of automobile travel are great. As a result, transit does not perform very well. Less dense development also means fewer trips, which cannot support high levels of service, making transit service less convenient. The result is that transit services in less densely developed areas are utilized mostly by those who are transit dependent. This situation generally becomes more pronounced with distance from downtown Boston. Travel to suburban locations is heavily oriented toward the automobile and there are few options for those who cannot drive.

These differences are discussed in more detail below by geographical area.

The Core Area

The largest concentrations of transit service are located in the "core area" of Boston, Cambridge and Somerville. (In these cities, 53 percent of usable land contains residential development with 12,658 persons per square mile, and 19 percent of usable land area contains commercial and industrial development with 11,655 workers per square mile.) With their extensive transit service, it is possible (although not necessarily convenient) to travel nearly anywhere in these cities without a car. This ability to travel without a car in many respects defines the core and differentiates it from suburban areas.

The major trip attractors in the core area are downtown Boston, Logan Airport, Copley Square/Prudential Center, Harvard Square, Kenmore Square, East Cambridge/Kendall Square and the Longwood Medical Area. In total, Boston and Cambridge attract 607,000 work trips per weekday. The largest sources of work trips are the Boston neighborhoods which have 282,528 employed residents, Cambridge which has 52,595 employed residents, and Somerville which has 42,787 employed residents.[2]

Downtown Boston

The Current Situation

The primary trip attractor in eastern Massachusetts is downtown Boston, which loosely includes Government Center, the Financial-Retail district, the North and South Station areas, and Park Square. This densely developed area contains most of the region's high-rise office buildings, major banks and other financial institutions, law firms, and hotels, as well as the Theater District and the Boston Garden. It also contains a number of major retail districts, Boston City Hall, and the largest state and federal government offices in Massachusetts. Each of these activity centers in itself has the capacity to attract large numbers of people, and when taken together, they form the greatest focus of activity in New England. Total employment in this area is 259,938 jobs.

As a result, much of the region's transportation system is also focused on downtown Boston. This includes four major highways—Route 1, I-93, the Mass Pike, and the Southeast Expressway—as well as a number of other major arterials. The rail network of rapid transit, light rail, and commuter rail is also radially oriented with a convergence on the downtown area. In addition, most bus services are designed to serve radial trips by either feeding the rapid transit system or operating into downtown. Finally, ferries also serve trips to and from Charlestown, Logan Airport and two south shore locations.

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[2]Based on the 1990 US Census.

As the local street network supplies distribution for the regional highway system, the rapid transit system provides distribution in the core area for transit trips. All of the rapid transit lines except the Red and Blue lines connect with each other (see Figure 4-1). The intersection of the four lines forms a "box" with Park Street, Downtown Crossing, State Street, and Government Center stations forming the corners (see Figure 4-2). These stations, plus others in the downtown area, make all of the downtown area accessible via rapid transit. Commuter rail lines terminate at North or South Station, both of which are on the fringes of the downtown area. At North Station, connections can be made to the Green and Orange Lines, and at South Station, connections can be made to the Red Line.

The downtown area is also served by a number of MBTA and private bus routes and ferry services which supplement the rail system. MBTA express bus service operates in three corridors: the North Shore (Routes 1 and 1A), I-93, and the Mass Pike. Mass Pike routes operate to and from the Financial District and provide good distribution within the downtown area. The North Shore and I-93 express routes are similar to commuter rail services in that most terminate at the fringe of downtown (at Haymarket), and the rapid transit system is used to provide distribution. MBTA local routes in the downtown area provide direct service from one neighboring city (Chelsea) and four Boston neighborhoods: Charlestown, the Fenway, Roxbury, and South Boston. Most local routes provide their own distribution within the downtown area. Private-carrier buses generally provide express service from beyond Route 128 to a number of locations within the downtown area including Park Square and South Station. Private-carriers provide varying degrees of distribution within the downtown area. Free access to the rapid transit system is provided to MBTA express bus monthly pass riders, but not to MBTA local bus, private carrier bus riders, or to MBTA cash fare riders.

All major highways and most rail services to downtown Boston are now at or near capacity during peak periods. For AM peak hour travel, the Southeast Expressway and I-93 carry the highest inbound volumes (at 10,600 and 10,300 vehicles in the peak hour), followed by the southern branches of the Red Line (9,500 inbound trips in the peak hour), southside commuter rail lines (9,500), and the northern end of the Orange Line (8,000) (see Figure 4-3). During the AM peak, the rapid transit and commuter rail lines carry higher total volumes than the major highways.

Red Line, Orange Line and commuter rail seating capacity and commuter rail parking supply have been increased over the past few years, but these services continue to operate at or near capacity on a day-to-day basis. During unusual occurrences and adverse weather, these services often exceed capacity, leaving passengers standing on the platform. Under normal conditions, there are parking shortages at 14 rapid transit stations and 15 commuter rail stations.

Outlook

For the future, downtown Boston will continue to be the primary market for transit trips and the one that can be most effectively served. The downtown Boston job market is projected by MAPC to grow by approximately 7.5 percent between now and 2020, and additional transit service will forseeably be needed to support this growth. As detailed in Chapter 5, the PMT recommends that much of this increase be served through a mix of projects such as commuter rail service improvements, expansion of park and ride facilities, a Green Line extension to Medford Hillside, new express bus services, commuter rail extensions to Worcester and Newburyport, and a possible North Station–South Station Rail Link.

Figure 4-1
Rapid Transit Lines

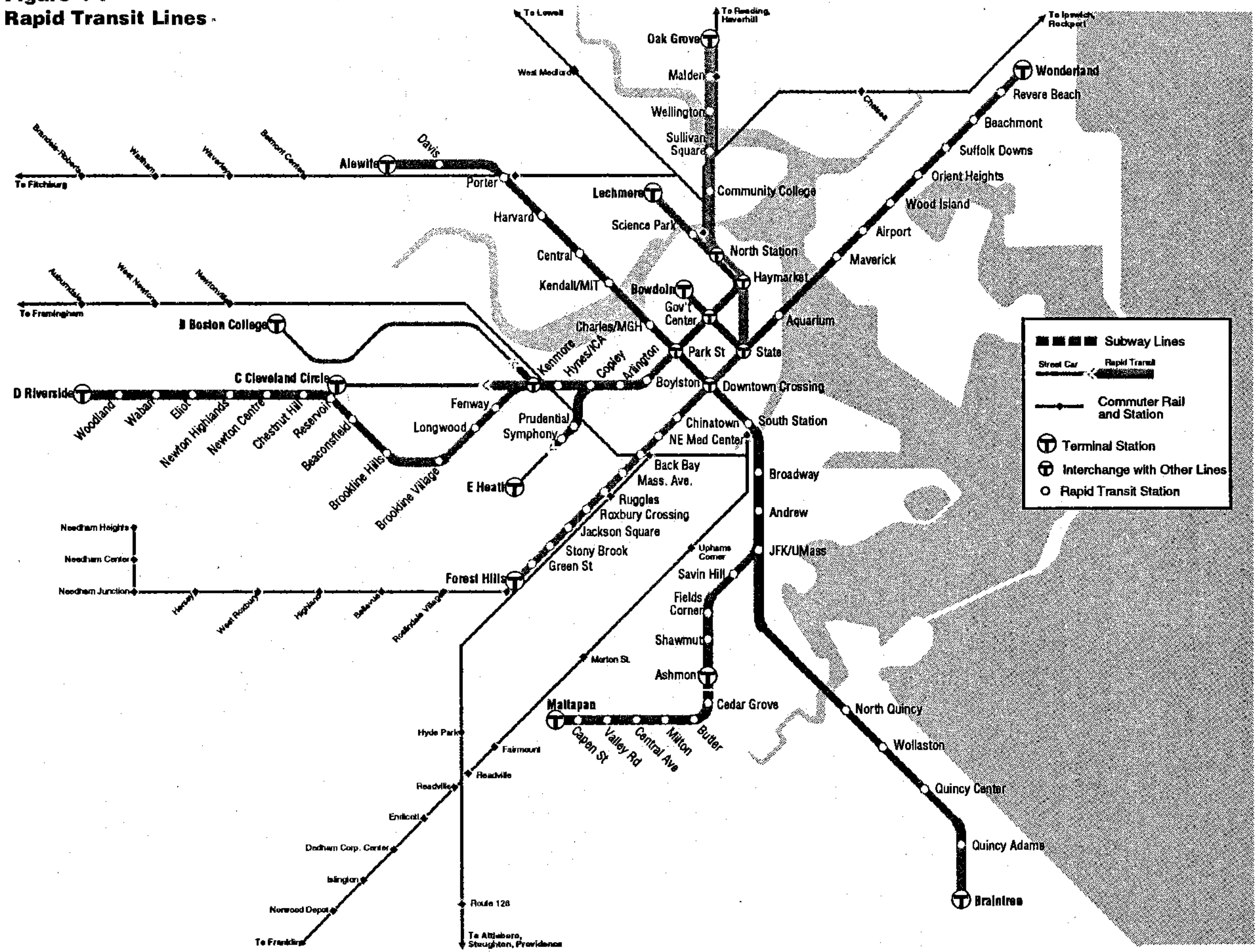


Figure 4-2
MBTA Services in Downtown Boston

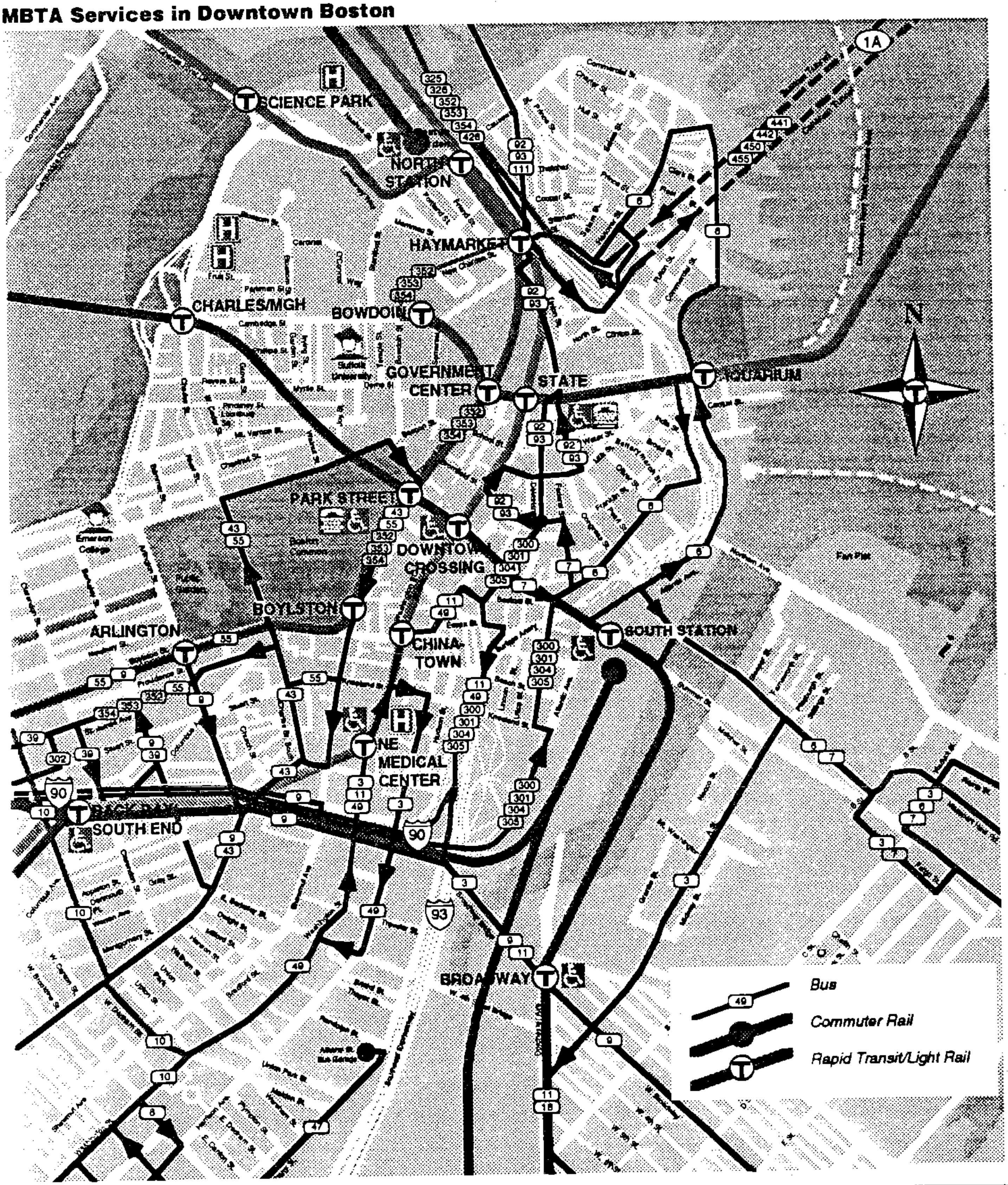
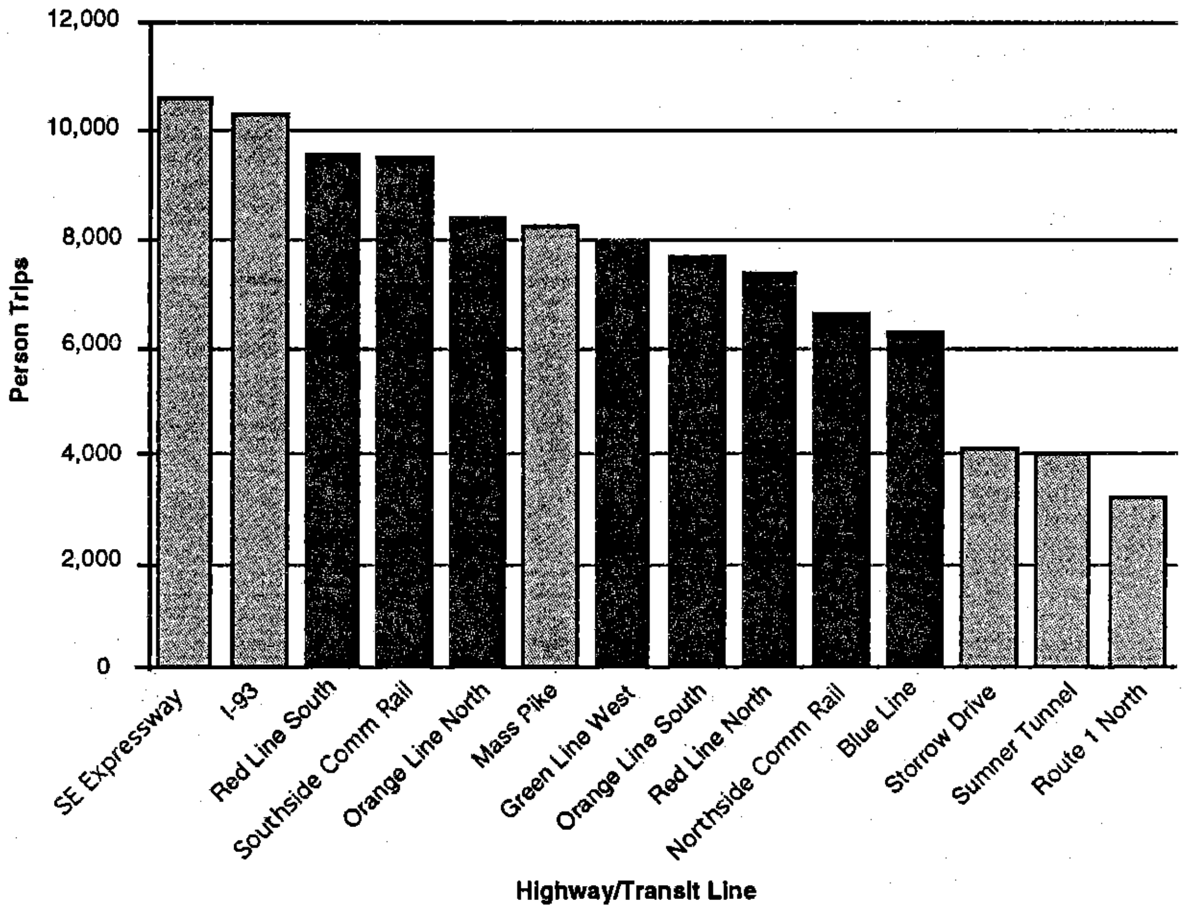


Figure 4-3
AM Peak Hour Volumes: Inbound toward Boston



Logan Airport

The Current Situation

Logan Airport is the region's second largest trip attractor with over 30,000 passengers per day, and over 15,000 employees. Public transportation to Logan includes Blue Line rapid transit, Massport Logan Express buses, several private bus companies, airport limousines, and the Logan Water Shuttle. Combined, these services carry approximately 22 percent of Logan passengers and 15 percent of Logan employees.

The Blue Line carries approximately one third of the transit users—about 3,000 trips per day. The major reason that the MBTA share is relatively small is that an MBTA trip usually entails two or three transfers, which is especially inconvenient when carrying luggage. These transfers are required because the Airport Station is located outside of the airport (necessitating a shuttle bus), and because the Blue Line has the most limited coverage of the rapid transit lines.

Outlook

Over the next thirty years, passenger demand is expected to nearly double, from 22.8 million trips to 43.5 million trips, through an average annual growth of 1.95 percent.

Recent estimates of the annual volume of air freight and air mail totaled roughly 350,000 tons. Air cargo is projected to increase at an average annual rate of 3.5 percent over the next few decades. Expected growth is based on an extended trends analysis of increases in aggregate personal income, decreases in the real costs of air travel, and technological and regulatory changes in the airline industry. Greater use of larger aircraft by the airline industry continues to reduce individual flight operating costs, by providing service to a greater number of passengers. Also, as larger airlines have discontinued service to regional airports, there has been an increase in commuter traffic from these airports to Logan.[3]

For transit to carry a greater share of airport traffic, better connections and more direct services will be needed. Massport is preparing to implement remote parking, ticketing and express bus facilities at South Station and in Woburn as well as planning for a major reconstruction of Logan's terminal facilities, which may include a people mover connection to the Blue Line's Airport station.

Other Core Area Business Districts

The Current Situation

In addition to downtown Boston, large-scale commercial and business districts are located in Copley Square, the Prudential Center, Harvard Square, Kenmore Square, East Cambridge/Kendall Square and the Longwood Medical Area. Each of these areas is located near one or more rapid transit or light rail stations (see Figure 4-4). The combination of the Green and Red rapid transit lines and several bus routes provides a radial transit system that serves each of these areas. For example, Longwood Medical area is served by bus routes 8, 47, 60, and 65, providing distant neighborhoods with Green Line connections. Further, the location of these areas along a radial rapid transit line provides direct connections with downtown Boston. However, transit trips between these areas often require travel on radial services to downtown Boston and then back out again. For example, a trip from Harvard Square to Kenmore Square requires a trip on the Red Line to Park Street and then a trip on the Green Line out to Kenmore.

Outlook

For the future, these areas should continue to be strongly oriented toward transit. The use of existing services can be increased by improving service, improving connections, and by instituting new services to fill gaps in the existing core area system. The MBTA is now studying methods for improving "crosstown" bus service. The PMT considers a number of potential projects. The largest of these would be the possible construction of a circumferential rail line (as a long-term project). However, additional study will be needed to determine the specific alignment, technology and cost-effectiveness. Other recommended projects include the Red Line - Blue Line Connector and an extension of the planned South Boston Piers Transitway from South Station to Boylston Station.

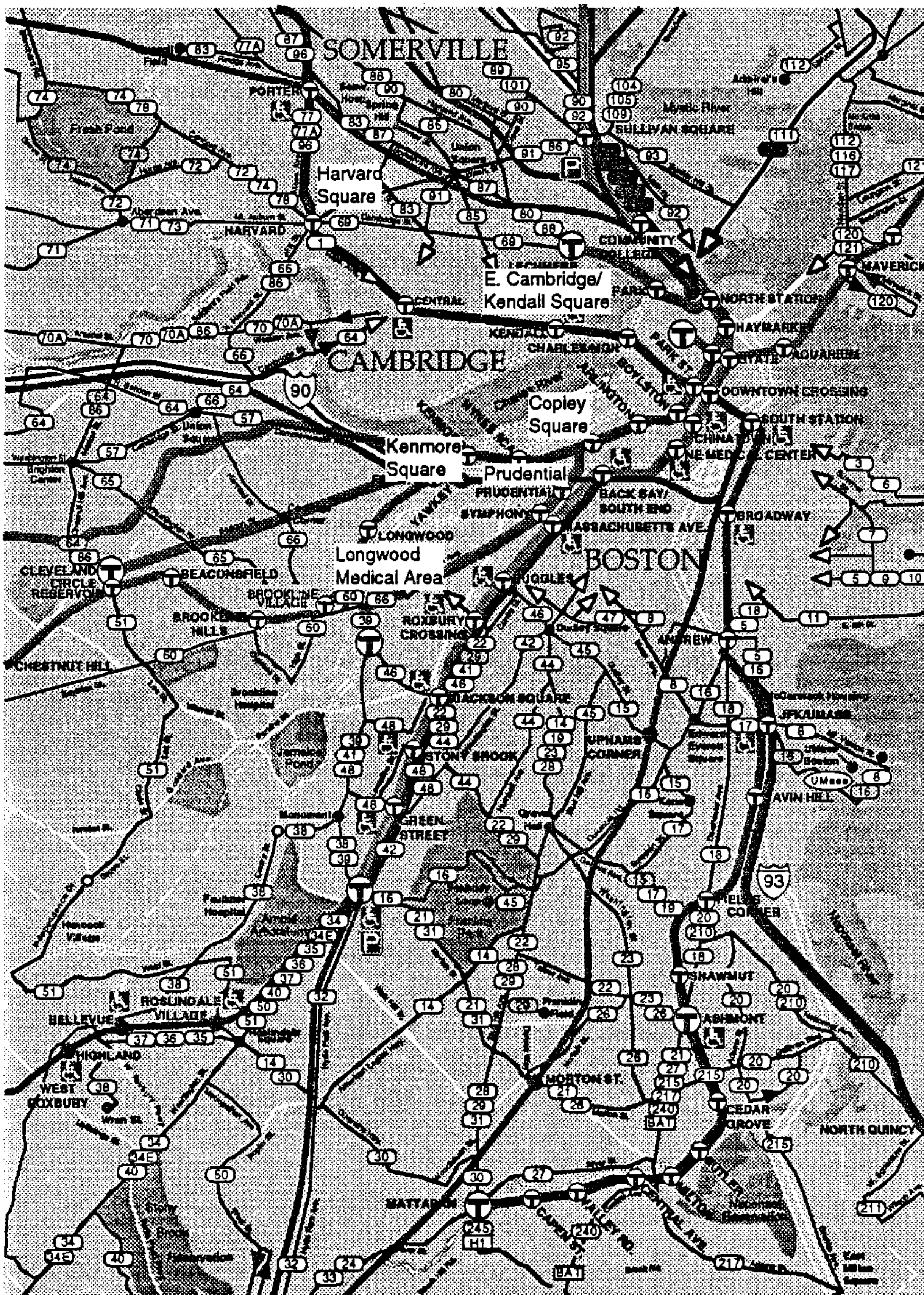
Core Area Residential and Mid-Density Commercial Areas

The Current Situation

The rest of the urban core is a mix of residential, commercial and industrial areas. Residential areas consist of neighborhoods with apartment buildings, multi-family homes, condominiums and single family dwellings. Although 11 percent of the usable

[3]Source: "Boston-Logan International Airport Final Generic Environmental Impact Report", Vanasse Hangen Brustlin, Inc., for Massachusetts Port Authority, July 1993.

Figure 4-4
Other Core Area Business Districts



land contains commercial and retail development in these areas, housing is the dominant land use at 57 percent of the land. Virtually all of these residential and mid-size commercial areas have access either to a rapid transit line or a bus route. Most of the service is focused on downtown Boston (either via direct rapid transit service or feeder buses to rapid transit), although there are also a number of crosstown bus routes providing direct service to Central and Harvard Squares in Cambridge, Copley Square, the Prudential Center, Kenmore Square, and the Longwood Medical Area.

Auto ownership in these areas is relatively low, ranging from 50 to 60 percent of households. In all neighborhoods, the low rates of auto ownership reflect the availability of transit. However, in the more affluent neighborhoods closer to downtown, this is often by choice and also reflects the difficulty of parking and proximity to downtown jobs. In the poorer neighborhoods, this more often is due to economic necessity.

Outlook

These areas should continue to be strongly oriented toward transit in the future, especially as services become more developed to provide more direct services to Copley Square, the Prudential Center, Harvard Square, Kenmore Square, East Cambridge/Kendall Square and the Longwood Medical Area. Service to these areas can be improved by providing better connections, and by instituting new services to fill gaps in the existing core area system. The PMT considers a number of other possible projects that could improve service to these areas. These include Green Line service improvements, Arborway service improvements, the Red Line - Blue Line Connector, and the South Boston Piers Transitway. These projects would expand capacity to and from business districts outside the downtown area.

Core Area Industrial Areas

The Current Situation

A number of large industrial areas are also located near downtown Boston. These include the South Boston Piers area, the Newmarket and South Bay areas, as well as large sections of Charlestown, Dorchester, East Boston, Somerville, Chelsea, and Everett. Compared to the high-rise office buildings in the Financial District, employment densities in industrial areas are low, making industrial areas more difficult to serve with transit than other parts of the core area.

Outlook

Although there is less demand to industrial areas because of low employment densities, access is nonetheless important. The highest levels of service can be provided when a high volume service can be operated through an industrial area, which can then act as a secondary market for the line. Routes designed primarily to serve industrial areas, such as MBTA Routes 3 and 6 in South Boston typically have low ridership. However, routes such as 8, 10, and 47 which serve both industrial and other areas have been more successful. Examples of potential new services of this type include the South Boston Piers Transitway, and improved circumferential service.

The Suburbs

Most trips originating in the suburbs are made to other locations within the suburbs.[4] However, most *transit* trips originating in the suburbs are to the core area, the largest

[4]For the purposes of this discussion, the "suburbs" are areas outside of the urban core.

number of which are work trips made by those who choose to use transit rather than to drive. The number of trips made from the suburbs to the core area supports frequent transit service, including rapid transit and commuter rail. These services are generally well utilized and approximately 32 percent of all work trips from the suburbs within Route 128 to the core are made on transit.

A much smaller number of transit trips are made to the suburban destinations (on average only two to four percent of work trips), and a high proportion of these trips are made by people dependent on transit . This is generally because trip origins and destinations are widely dispersed, and the number of trips between any two points is much lower than to core area destinations. As stated above, the lower number of total trips cannot support as high a level of service as the core area, which makes service less convenient and acts as a deterrent to using transit for those who have access to an automobile.

Core-Oriented Trips

The Current Situation

Consistent with the highest trip volumes, most of the public transportation service in the suburbs is oriented toward the downtown area, consisting of radial rapid transit and commuter rail lines, feeder and express bus services, and commuter boat services (see Figure 4-5). The eight main branches of the commuter rail network have stations in 57 cities and towns in the Greater Boston area from near the New Hampshire border in Lowell and Haverhill, to Providence, Rhode Island (see Figure 4-6). In many cases, stations are located in town centers. Because these are generally the most densely developed areas of a town, this placement allows the highest number of people possible to walk to the station. Newer stations are located near major highways and primarily serve park and ride commuters, which is typically the largest market. At many stations with parking lots, both older and newer, demand for parking now meets or exceeds supply.

Rapid transit does not extend as far as commuter rail, serving only the most densely developed suburbs. Outside of the core area, 13 of the rapid transit stations have large park and ride facilities. The largest of these parking facilities are located at Quincy Adams and Alewife, each with more than 2,000 spaces, and Riverside, Braintree, Wonderland, North Quincy and Wellington, each with over 1,000 spaces. Before the recession, nearly all of these were utilized beyond capacity and filled before the end of the morning rush hour.[5] The recession has reduced demand somewhat, but many of these stations continue to operate at or near capacity.

The rapid transit system is served by feeder buses at 13 major station terminals. Stations that serve suburban markets include Malden Center (feeder bus from the north), Quincy Center, Ashmont and Forest Hills (feeder bus from the south), and Alewife (feeder bus from the west). The success of feeder bus service is mixed—some feeder bus routes, such as routes 23 and 28 serving Ashmont and Mattapan Stations, are very heavily utilized. Others, such as routes 84 and 221, serving Alewife and Quincy Center stations respectively, are among the least utilized in the system. In general, a large proportion of those who have cars available prefer to drive to the station because of the convenience and the travel time savings. While the provision of suburban park and ride facilities may encourage some that could use feeder bus service to drive, these facilities also encourage those who would otherwise make their whole trip by automobile to use transit for most of it. The additional

[5]Source: "1989 MBTA Revenue and Service EIR," CTPS, November 1990.

Figure 4-5
MBTA Core-Oriented Rail, Express Bus, and Ferry Services

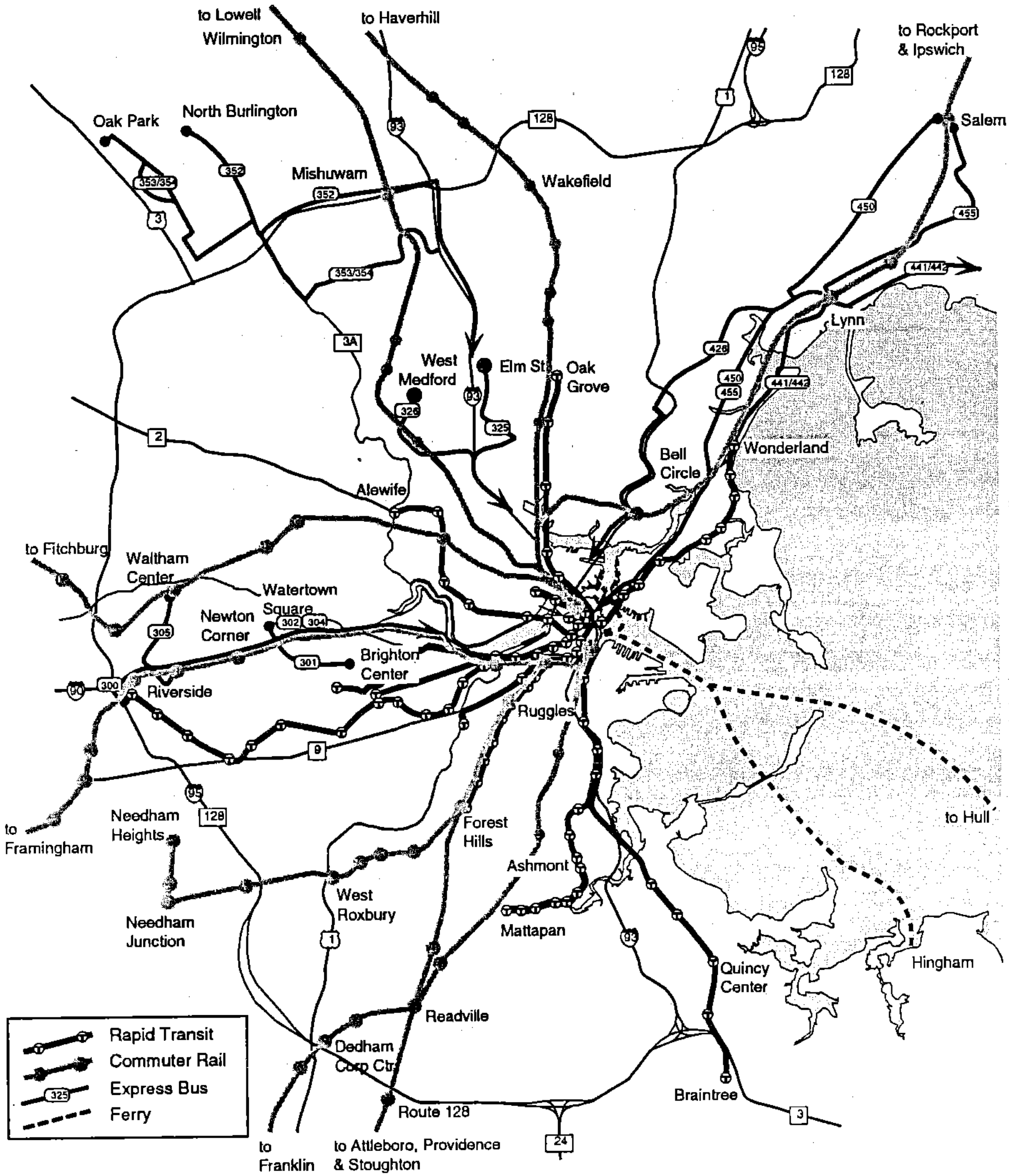
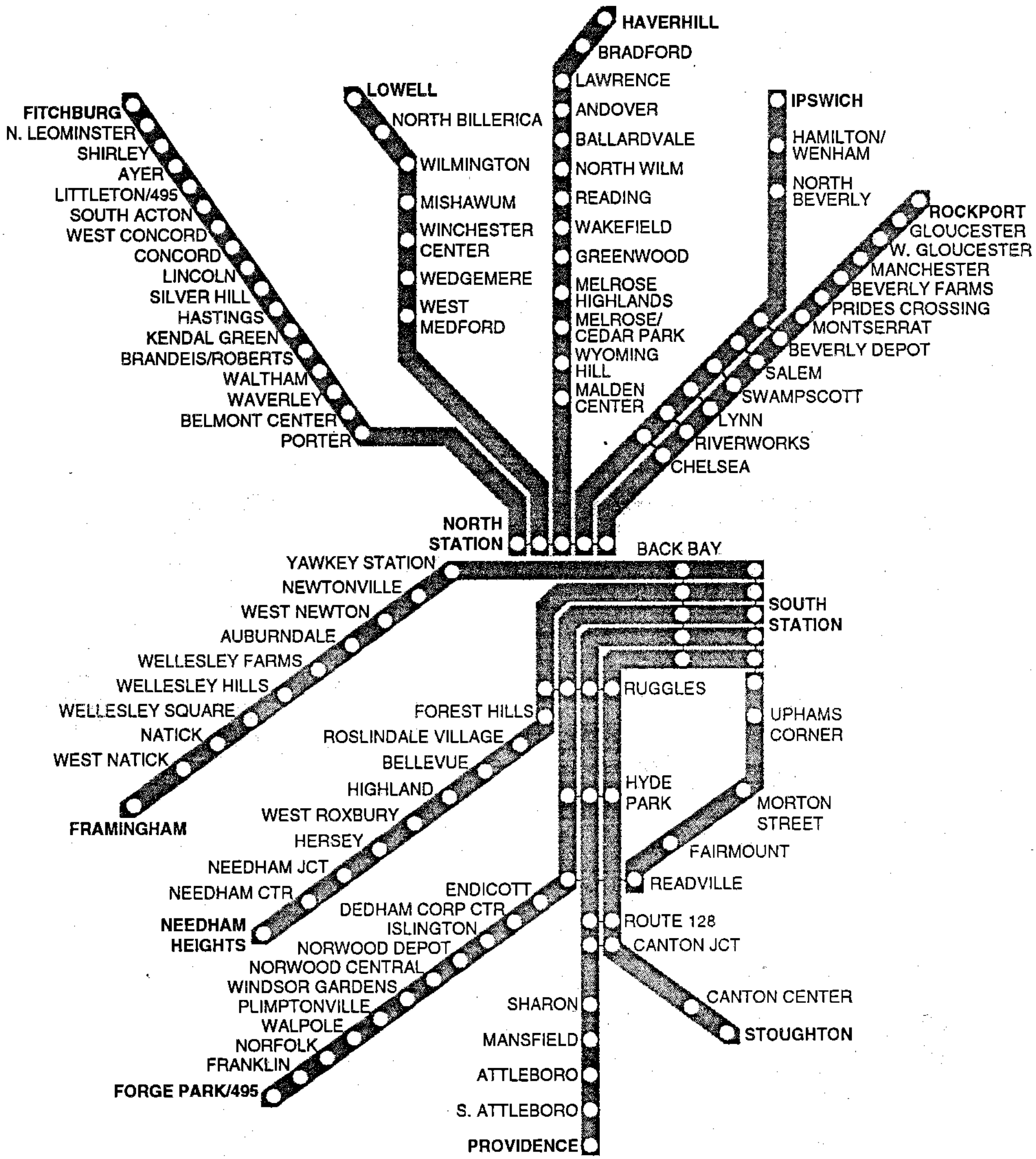


Figure 4-6
MBTA Commuter Rail Lines and Stations



trips gained through the provision of park and ride lots outweighs the feeder bus loss, provides options, and make service more convenient for many users.[6]

In addition to feeder bus service, 41 bus routes run directly to downtown Boston and other core area locations. The MBTA operates express routes to downtown Boston from the North Shore, in the I-93 north corridor, and along the Mass Pike. Seventeen private bus companies also provide express service to downtown Boston, seven of which serve Logan Airport as well[7]. Most private-carrier routes originate beyond I-495 from Hyannis, New Bedford, Fall River, Worcester and Andover in Massachusetts, as well as Concord and Portsmouth, New Hampshire, and Providence, Rhode Island. Major differences between MBTA and private routes are that private carriers generally use more comfortable "over the road" coaches and charge higher fares. Also, there is no provision for free transfers from private buses to rapid transit (or other MBTA services) for downtown Boston distribution. Private-carrier services are for-profit operations, and consist of a mix of non-subsidized and subsidized operations.[8]

Finally, commuter boats provide service from two south shore suburban communities—Hingham and Hull—to downtown Boston. The Hingham commuter boat services are privately operated under contract to and subsidized by the MBTA. The Hull service runs without MBTA subsidy.

Outlook

Continued employment growth of the core area will continue to increase travel from the suburbs. Based on regional projections developed by MAPC, most of the new trips to the core area will be made from more distant locations, meaning that the reach of the radial system may need to be extended in order to serve these trips. For trips from around and within Route 128, access to commuter rail, rapid transit, and express bus services can be provided through feeder bus services and park and ride facilities. From outside of Route 128, trips will originate from a large number of widely dispersed locations that will be difficult to serve with fixed-route bus services. Locally based transportation management associations can help promote effective feeder buses and even offer their own shuttle routes. However, even with these services, the automobile will continue to be an important access mode to radial transit services. To serve these park and ride trips, convenient access to parking facilities from major highways will be needed.

In addition, it is likely that mass transportation services from the suburbs to the core area will continue to be provided by the MBTA as well as by a variety of private carriers. Better integrated fare policies[9] between carriers, both public and private, could make the existing system function more effectively as an intermodal whole, and thus provide improved mobility throughout the region.

6For detailed information on the additional trips that can be attracted by the provision of park and ride lots, see the "Park and Ride Expansion" section of Appendix G.

7Source: "Car Free in Boston: the Guide to Public Transit in Greater Boston and New England", Association for Public Transportation, 8th Edition, 1993-94.

8For a description of private-carrier bus services, see the "Private Carrier Bus Service" section of Appendix C.

9A mentioned above, many of the private carrier bus services are already subsidized. These subsidies could also be used to provide uniform fare levels that would provide improved fare equity throughout the region.

Trips Within or To the Suburbs

The Current Situation

The number of trips made to the suburbs from both urban and suburban locations (approximately 80 percent of the regional total) greatly exceeds the number of trips made to the core area. However, most of the trips to the suburbs are made between areas that are not densely developed and for which origins and destinations are widely scattered. These two characteristics mean that there are relatively low total trip volumes between most pairs of origins and destinations. This, in turn, makes it difficult to provide a high level of transit service in a cost-effective manner. Further, an overwhelming majority of trip attractors have free parking. The combination of low levels of transit service and free parking makes automobiles much more convenient for most suburban trips.

Existing MBTA service in the suburbs is generally located in the more populous and densely developed suburbs and nearby cities, such as Quincy, Medford, Watertown, Waltham and Lynn. Most of these services have a historical basis, in that those routes were instituted by private operators when fewer trips were made by car and when there was a greater focus on travel to those downtowns. As the geographical reach of Boston has grown, these routes have been updated to provide connections to the rapid transit, commuter rail, or express bus systems so that they also serve core-oriented trips. The trips made by downtown Boston-bound riders on these local suburban routes helps to support a higher level of service that benefits the much smaller suburban transit market. These services also provide opportunities for reverse-commutes made by residents of the urban core who work in the suburbs.

In addition to its own service, the MBTA partially subsidizes local suburban bus services in twelve communities. These local systems range from one twelve-passenger van, to three minibuses and a full size bus. These services are administered by individual towns and mostly operated by private contractors. Suburban services are designed to provide intra-town services and most focus on providing service for non-work trips. These suburban services are often not coordinated with MBTA services and there are no joint fare arrangements. As described in the "Future Strategies" section, suburban Transportation Management Associations (TMAs) could be helpful in this regard.

Outlook

Given a continuation of existing development patterns in the suburbs, the suburban market will continue to be difficult and expensive to serve with traditional transit. Concentration of development may, over time, create densities that can support transit in some areas. In other cases, traditional transit will likely continue to be utilized mainly by those without access to an automobile.

At the same time, there may be opportunities to connect trunkline transit services with employer-sponsored shuttles to provide direct connections to worksites, and to coordinate suburban services with MBTA services through the participation of TMAs and the assistance of CARAVAN for Commuters. While these types of improvements would not be expected to carry a large share of the total number of trips, they would provide additional travel options that could provide some congestion relief. Also, especially in the suburbs, better integration of fare policies between the MBTA, local suburban systems, and private-carriers could make the existing system function more effectively as a whole.

Future Strategies

The provision of transportation facilities and services is a shared responsibility of the federal, state, and local governments, regional transit authorities and planning agencies, and private interests. This shared responsibility reflects the fact that the transportation system serves public and private interests at the local, state, and national level. While interests of specific parties are diverse, the most important are shared:

- The transportation system should be well maintained and efficiently operated.
- It should be preserved and upgraded to meet current and future needs.
- It should contribute to a strong regional economy and serve as a stimulus for future economic growth.
- It should provide mobility for the region's residents.
- It should protect and enhance the region's quality of life.

At the federal level, the Intermodal Surface Transportation Efficiency Act of 1991 (ISTEA) requires a number of changes in the way planning is conducted. It places its major emphasis on the more effective use of existing facilities, including both intermodal and multimodal approaches to planning to meet mobility needs.[10]

For the future, the MBTA's priorities for future service improvement and expansion are as follows:

1. Preserve the existing system.
2. Make the system accessible as required by the Americans with Disabilities Act.
3. Expand and improve service as required to meet Clean Air Act requirements.
4. Expand and improve service as required to mitigate CA/T short-term construction impacts and long-term effects.
5. Additional expansion.

In expanding and improving the system, a number of strategies can be employed. These strategies, which are as described below, are based on the implementation of federal, state, regional, and MBTA policies and goals,[11] and ISTEA.

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[10]As defined by the federal government in its proposed rules for the ISTEA management systems, multimodal refers to more than one mode to serve transportation needs in a given area. Intermodal refers to connectivity between modes as a means of facilitating linked trip making. Intermodal emphasizes connections (transfers of people or freight in a single journey), choices (provisions of transportation options to facilitate trip making), and coordination and cooperation (collaboration among transportation organizations). Intermodal is included within the meaning of multi-modal.

[11]Sources: PMT Phase 2 report; Moving America: New Directions, New Opportunities, U.S. Department of Transportation, February 1990; The Transportation Plan for the Boston Region, Metropolitan Planning Organization, February 1983; 1978 Revised Program for Mass Transportation, Executive Office of Transportation and Construction, 1978; MBTA Revenue and Service Environmental Impact Report: 1989 Fare Increase, Central Transportation Planning Staff for the Massachusetts Bay Transportation Authority, 1990.

As described in previous sections, traditional transit is best suited to serving the high volumes of trips that are made within or to the core area. As detailed in Chapter 5 through 9, the projects that would have the largest ridership impacts and greatest air quality benefits are projects that would serve the core area. The core-oriented projects are also the ones that would divert the most automobile trips to transit, and thus have the greatest ability to reduce highway congestion in both the core area and the suburbs, including on Route 128. As a result of these characteristics, the major emphasis of mass transportation improvements for core-oriented trips will be to make transit services more attractive in terms of cost, convenience, and travel time.

In the suburbs, the character and density of development makes the cost of providing a high level of transit service to all locations prohibitive. As a result, mass transportation improvements in the suburbs will be directed toward the most densely developed areas and toward providing a basic level of mobility. Existing MBTA services do provide a large amount of service in the suburbs within Route 128, but most of it is oriented toward the core area. Increasing suburban traffic congestion, as evidenced on Route 128 and its adjoining access roads, points out the need for suburban transportation improvements. However, because origins and destinations are widely dispersed and overall trip volumes between any two given points are typically low, the demand for individual bus routes is low compared to that for core area services and for the type of equipment used by the MBTA. For example, it would be very difficult to fill standard MBTA forty-foot buses on a route to a suburban office park. As a result, it would be more cost-effective for these services to be provided through an expansion of the suburban program or by Transportation Management Associations, which can typically provide services at lower cost and more flexibly than the MBTA. TMAs, which are typically private nonprofit groups formed to facilitate private sector involvement in addressing transportation issues, could be helpful in a number of ways:

- Mitigation of transportation impacts. In cooperation with CARAVAN for Commuters, Inc., TMAs encourage transit, shared ride commuting, and variable work hours.

- Transportation services. Some TMAs operate shuttle services among work sites or to connecting MBTA services.

- Corporate support/responsiveness to local needs. TMAs work with local employers, are aware of local needs, and can often provide more timely response to those needs than other agencies.

- Private/public cooperation. TMAs can often act as a bridge between the private sector and public transportation agencies.

The challenges involve the funding of such systems and ensuring both that regional needs are met and that individual systems and private services are well coordinated so that they form an integrated system. This will require the coordination and cooperation of a number of different parties, both private and public.

Core-Oriented Trips

For trips to, from, and within the core area the emphasis should be on providing services that are more attractive and that will provide access to and from more of the region. This can be done in the following ways:

- Use existing facilities and services more effectively.
- Make transit service faster.
- Provide better access to transit.
- Fill gaps in service.
- Provide more efficient transit connections.
- Direct mass transportation improvements to areas that are now or will soon be severely congested.
- Expand capacity to meet existing and projected demand.

Use Existing Facilities and Services Most Effectively

Different modes have different service characteristics. As a result, different modes are better suited to certain areas and types of operations. Rapid transit is a high capacity service that can accelerate and decelerate quickly, and therefore is well suited to serving large volumes where there are closely spaced stations. Commuter rail can also carry high volumes, and at higher speeds, but with slow acceleration. This makes commuter rail best suited to carrying high volumes long distances with few stops. Although door-to-door travel time for transit trips tends to be longer than that for the automobile, commuter rail and rapid transit services operate on exclusive rights-of-way,[12] which means that they can provide travel time savings versus automobile travel in congested areas. Buses are very flexible and can provide their own feeder service as well as better downtown distribution, but have lower capacities, and when they operate in mixed traffic, usually provide slower service than other modes.

With a few exceptions, the existing system has evolved around the use of different modes in different areas and for different types of services on the basis of these characteristics. Further, the emphasis on one mode versus another has often changed in response to changes in the region's travel patterns. Most recently, sharply higher housing prices through most of the 1980s in the core and inner suburbs pushed many people far from Boston, which has increased trip lengths (as described in Chapter 3). These changes began at a time rapid transit expansion was being emphasized and when commuter rail service was being reduced. However, in response to these changes, the emphasis has since shifted toward rebuilding and restoring commuter rail services, rather than the previously planned outward expansion of most rapid transit lines. Today, service can be characterized as focused around the following modes, by area:

- In the core area, most service is provided with a mix of rapid transit, direct bus service, and feeder bus service to the rapid transit system. Direct bus service is generally operated in areas without convenient access to the rapid transit system: Charlestown, sections of Roxbury, South Boston, Chelsea, and the Fenway.

- From the suburbs within Route 128 to the core, there is a mix of commuter rail (all nine lines), rapid transit (Blue Line, Orange Line north, Green Line west, Red Line south), express bus (from the North Shore, and along I-93 and the Mass Pike), and feeder bus to the rapid transit system (to all lines).

[12]Except for the B, C, and E branches of the surface Green Line.

- From the Route 128 vicinity, there is a mix of rapid transit (Route 128 stations on the Quincy branch of the Red Line and the Riverside branch of the Green Line), commuter rail (Route 128 stations on the Lowell, Franklin, and Attleboro lines), and express bus (from Burlington without parking and from Riverside with parking).

- Beyond Route 128, there is a combination of commuter rail (eight of the nine lines) and private-carrier express bus services (by 16 carriers).

For future expansion, the most cost-effective mode chosen should be selected on a case-by-case basis. However, based on past experience and current development patterns, the following can be expected:

- Rapid transit expansion in the densest and most congested corridors within Route 128.

- Commuter Rail expansion for long distance travel to and from the core area.

- Buses for access to and from rapid transit stations, local circulation, and express service in non-rail corridors.

- TMA shuttle services and CARAVAN ridesharing services for dispersed development.

Over time, changing conditions can mean that an existing mode is no longer the most appropriate. This has been the case in the past where horse-drawn routes were converted or replaced by trolleys and commuter rail, and then to either bus or rapid transit. Most conversions since the end of World War II have been from streetcar to bus or from railroad to rapid transit. In some cases, such as with the Old Colony commuter rail lines, service that was discontinued is now being restored. Also, high speed rail is now being planned or considered for intercity corridors, such as Boston–New York and Boston–Springfield. For the future, conversion of services should continue where the result would be more cost-effective operation and/or improved service.

Where the current mode is still the most appropriate, existing services should be preserved and upgraded to improve service, efficiency, and/or cost-effectiveness. These types of improvements range from modernized stations, such as the Blue Line Modernization program, and better commuter rail and bus passenger amenities to improved Green Line operations.

Finally, an expansion of a variety of mass transportation services, coupled with an increased reliance on the private sector to provide services, will present the potential for services to become more fragmented. To prevent this from occurring, increased coordination and cooperation will be needed. For the various pieces to operate as an integrated system, coordinated fares and joint pass arrangements would be beneficial.

Make Transit Service Faster

Of the factors that influence the decision to use transit or to drive, travel time is one of the most important. With the exception of rapid transit and commuter rail trips that both begin and end near the line, this is also an area in which transit is often at the greatest disadvantage. Therefore, to make transit more attractive, an emphasis should be placed on reducing transit travel times. This will benefit existing riders, as well as attract new

riders from automobiles. This will relieve traffic congestion and, in turn, result in more effective use of both existing highway and transit facilities.

Travel times on most transit services can be improved. However, there is usually a trade-off involved between higher speeds and higher operating costs. On public roadways, preferential treatments for bus and other high occupancy vehicles must be balanced against the impacts on automobile and truck traffic. This PMT focuses on travel time improvements where there would be:

1. a large number of trips diverted from automobiles;
2. large travel time savings to existing riders; and/or
3. where travel time savings for transit riders would outweigh the additional time preferential treatments would cause automobiles and trucks.

As detailed in Chapter 5, recommended improvements to make transit faster include operating express commuter rail service and increasing the maximum operating speeds on the Rockport/Ipswich, Haverhill/Reading, Lowell, and Franklin Lines, improving Green Line operations, providing more direct bus service to downtown Boston, and providing more conveniently located park and ride lots.

Provide Better Access to Transit

The region's transportation system provides a number of passenger travel options, including single-occupant automobile, transit, bicycles and HOVs. While most people usually use the same mode or combination of modes each day, they also make occasional use of other modes. Further, most transit riders use more than one mode each day, either for access to or egress from the transit system, or as part of the transit trip. One of the major emphasis areas of ISTEA is that multiple travel options should be provided and that there should be smooth and efficient connections between modes.

To accomplish these goals, transit options should be provided in major corridors, and there should be convenient automobile, pedestrian, and bicycle access to transit stations and park-and-ride facilities. Transit service should be configured to minimize transfers, to coordinate service, and to provide a comfortable environment at transfer locations. Also, facilities and services should be provided in a manner that allows travelers to easily shift between modes, both for individual trips and on a day-to-day basis.

Convenient pedestrian access and bicycle facilities are desirable at all rapid transit and commuter rail stations, and major express bus facilities. For stations within the densely developed urban core, feeder bus access, rather than auto access, should be emphasized in the design and operation of services.

High priority improvements that would improve access to core-oriented transit services are the construction of intercept parking facilities located along major highways, the expansion of existing park and ride facilities, and the construction of park and ride facilities for existing express bus routes.

Fill Gaps in Service, Provide Better Connections, and Extend Service to New Areas

The geographical coverage of mass transportation services within and to the core area is extensive and there are few gaps in service coverage. Within Route 128, the only significant gaps in express-type service are in the Route 1 North corridor and between

Burlington and Alewife along Routes 128 and Route 2. Demand for services to the core has grown significantly in areas beyond Route 128—especially between Route 128 and I-495, but also from southern New Hampshire, south and west of I-495, and Cape Cod. However, the PMT analysis has shown that, with the exception of the Framingham to Worcester corridor, demand falls off rapidly beyond I-495 and/or a high proportion of the residents of those areas are already driving to existing commuter rail lines. As a result, extension of most commuter rail lines would provide better service to many existing riders, and improve air quality to the extent the auto access distances are reduced, but would do so at a high cost and attract relatively few new transit riders (see also Appendix G).

Within the core, new services will be needed to support new economic development. This may occur in areas such as the South Boston Piers and the Charlestown Navy Yard. Existing express and local bus services should also be extended into more of downtown to increase passenger convenience by eliminating long walks or the need to transfer.

New services could also be beneficially instituted within the core area to facilitate trips that are currently difficult to make by transit due to the lack of direct service or convenient connections. These include circumferential trips, trips to Logan Airport, trips involving the Blue and Red Lines, trips involving northside and southside commuter rail, and the connection between the Mattapan High Speed Line and the Red Line. The discussion of recommended projects in chapters 5-9 present detailed descriptions of several new services that expand the service area and improve connections.

Direct Mass Transportation Improvements to Congested Areas

Mass transportation services can provide great benefits in congested areas since transit use relieves traffic congestion. The state is now in the process of developing a Congestion Management System (CMS) to identify areas where congestion occurs or may occur, identify the causes of congestion, evaluate strategies for managing congestion and enhancing mobility, and developing a plan for implementation of the most effective strategies. Where feasible and cost-effective, transit improvements should be directed to areas where they can relieve congestion.

Enhance Capacity to Meet Existing and Projected Demand

Between now and 2020, MAPC and CTPS projections indicate that the total number of trips (work trips and non-work trips) into the core area will increase by up to 30 percent. As discussed above, there is limited potential for significant expansion of highway capacity. As a result, much of the additional demand will need to be met through improvements to the transit system. Potential projects to meet that goal include the expansion of commuter rail services through the operation of express trains on the Rockport/Ipswich, Haverhill/Reading, Lowell, and Franklin Lines, a higher level of service and new stations on the Needham Line, park and ride expansion, including the construction of intercept station along major highways, new express bus routes, and commuter rail extensions to Newburyport and Worcester.

Suburban Trips

For trips within the suburbs, the short-term emphasis will be more on providing a basic level of mobility. Higher level services will be targeted toward serving more densely

developed suburbs, and areas where transit service could relieve congestion. This emphasis reflects the historical difficulties in providing transit in the suburbs.

Provide a Basic Level of Mobility

Mass transportation improves the quality of life for many of the region's residents by providing travel opportunities that may be otherwise unavailable. The MBTA has made significant portions of its system accessible to those with disabilities; further accessibility improvements are now in the construction or planning stages. As required by the Americans with Disabilities Act (ADA), all future services will be accessible to disabled people.

In the suburbs, the MBTA now provides most of the transit service, but there are also a number of town-administered services and private and TMA-operated shuttles. Because of low volumes and the MBTA's high cost structure, it is not cost-effective to provide MBTA services throughout the suburbs. Instead, the expansion of town-administered, private, and TMA services should be encouraged. Alternative services should be coordinated with MBTA services, and joint fare arrangements should be instituted. Care will be needed to ensure that services operated and administered by a number of different entities will operate as an integrated system.

Use Existing Facilities and Services Most Effectively

As discussed above, there are a number of services provided in the suburbs, primarily by the MBTA and towns. Town services are usually partially subsidized by the MBTA through the Suburban Bus program, which provides operating assistance to locally-administered services in 10 communities.[13] These services are generally intra-community services that are designed to serve shopping trips. The MBTA also contracts with four private carriers to operate seven routes within the MBTA district.[14] In addition to MBTA and MBTA-subsidized services, there are various private shuttles and a TMA-operated shuttle between Alewife and Route 128 businesses in Lexington and Waltham.

At the present time, all of the different services operate as separate systems. There is little or no schedule coordination, even between MBTA and MBTA-subsidized services. For the different services to operate as an integrated system, schedule coordination will be needed. In addition, private shuttle connections to existing trunk line services at rapid transit and commuter rail stations should be encouraged. This could result in increased reverse commuter travel on existing services.

Fill Gaps in Service/Providing Better Connections

Filling gaps in existing suburban services is related to providing a basic level of mobility. As with most types of suburb-to-suburb trips, the demand along individual routes will usually be relatively low. Considering these characteristics, service needs should be assessed and administered by local communities and/or TMAs rather than operated by the

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[13]Bedford, Beverly, Burlington, Dedham, Framingham, Lexington, Lynn, Mission Hill, Natick, and Norwood. Waltham is currently planning to begin a suburban bus program.
[14]Hull – Hingham by People Care-ier's, Inc.; Fulton Street – Meadow Glen Mall in Medford by Hudson Bus Lines; Canton – Mattapan Station by Hudson Bus Lines; three Peabody routes (including service to Salem) by Michaud Bus Lines; Winthrop local service by Paul Revere Transportation Co.

MBTA. However, in addition to the services provided by existing suburban programs, inter-town services and connections to MBTA services should be provided.

As an example, Lexington and Burlington both have suburban programs and MBTA local bus service. Currently, the three different services have three different fare structures, and no joint passes are available. Also, the Burlington and Lexington suburban services start near the end of the morning peak, so that these services cannot be used to access MBTA radial services that do provide peak period service. Lastly, the town services are focused on providing intra-town services, so that even though both operate to and from the Burlington Mall, the lack of coordination makes inter-town travel extremely difficult. Relatively minor changes to these existing programs could significantly expand travel opportunities. These changes include:

- Beginning service earlier and coordinating schedules with MBTA routes in order to make service available to those making out-of-town work trips.

- Combining individual town routes that end at town borders into single routes, to provide for inter-town trips.

- Implementing joint fare arrangements to make the individual services work better as an integrated system.

Focus Mass Transportation Improvements to the Most Densely Developed and Congested Suburban Areas

As described earlier, the major obstacle to providing frequent transit in the suburbs is the low density of development which results in lower volumes of trips than in urban areas. However, some areas are becoming more densely developed, and there are efforts to encourage more compact development in certain areas. Where this occurs, conditions will become more conducive for transit service, and especially in congested areas, attempts could be made to provide transit service that would shift riders from automobiles. The PMT examined a scenario for circumferential bus service on Route 128. This service could generate a significant amount of ridership but with a very high operating cost. It is recommended that more limited services that are more focused to specific Route 128 markets be examined—for example, services from various points along Route 128 to Waltham or Burlington.

Chapter 5
Recommended Program

This chapter presents the recommended program for mass transportation improvements through the year 2020. Details on specific projects are presented in Chapters 6 through 9. Funding and implementation are discussed in Chapter 10. Major elements of the program are as follows:

1. **Preservation of the Existing System**
   The first priority is to ensure that the existing system is preserved. Over the past decade, and continuing today, a large portion of MBTA capital resources have been used to correct for problems of past deferred maintenance. Expenditures to correct for deferred maintenance, which are often significantly higher than the cost of proper maintenance, result in less funding for new services. By properly maintaining the system, more future funds can be directed toward improving service and relieving congestion.

2. **Accessibility Improvements (ADA-Related Projects)**
   After maintenance of the system, the initial focus of the PMT will be projects to make the system accessible as required by ADA. The MBTA has filed a Key Station Plan which it will carry out over the coming years to comply with ADA. The accessibility improvements will have benefits for able-bodied users of the system as well.

3. **SIP and CA/T Mitigation Service Expansion Projects**
   The projects that will be most effective for Clean Air Act and CA/T mitigation purposes will be those that divert the most trips from automobiles. Transit is most successful in congested corridors and most projects that create a large number of automobile trip diversions will also provide traffic congestion relief.

4. **Additional Expansion**
   In addition to meeting ADA, Clean Air Act, and CA/T Mitigation requirements, a number of other expansion projects are recommended. However, because of the time and cost that will be required to meet regulatory mandates, all of these projects are subject to available and prudent funding, and most are long-range projects.

The expansion projects examined in the PMT were analyzed relative to each other and in terms of their absolute impacts. In most cases, the PMT analysis has provided the information necessary to determine which projects would be the most beneficial. However, in a few cases, some new issues were raised that were beyond the scope of the PMT effort. As

discussed below, these issues were specific to individual projects and will require more detailed or more comprehensive examination. Further, a number of issues that are beyond the scope of the PMT analysis, but that will likely affect the PMT, still need to be resolved. These include:[1]

- Uncertainty with respect to future federal funding levels. This could require either a smaller program, or allow for a larger one.

- The determination of environmental and community impacts of individual projects (through federal and/or state environmental processes). This process will likely reduce the size of the program.

- The determination of MBTA needs relative to a balanced transportation program, as determined through the regional and state transportation planning processes and by EOTC's Capital Finance Review Committee.

- Substitutions for SIP and CA/T Mitigation projects (now being examined by EOTC, the MBTA, and the CA/T project). Substitutions would likely reduce the size of the program.

- Updates to the Boston area's Regional Transportation Plan which will include corridor-level needs assessments. These needs assessments may indicate that some changes to the overall program would be appropriate.

Also, this PMT was prepared based on current projections of future conditions. These projections generally assume a continuation of existing growth patterns and the absence of strict transportation control measures that would cause large shifts from automobiles to transit. Should these conditions change, the PMT would have to be revised to reflect those changes.

Based on the possible implications that these issues may have on the PMT, a relatively large number of projects has been included in the recommended program This was done to provide the flexibility that will be needed to refine the PMT as these issues are resolved. On a year-to-year basis, and for any given period of years, it will be necessary to implement the most effective projects within the limits of the available funding.

Program Development Process

At the beginning of the PMT, a series of public "transportation town meetings" were held throughout the region to solicit community and public input.[2] These efforts resulted in a large and diverse array of potential improvements (as documented in the Phase 1 report "Initial Study of Suggested Transportation Improvements").

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[1]See Chapter 10 for additional detail.

[2]The Transportation Town Meetings were also intended to provide much of the same information as would have been generated through a formal needs assessment. A more analytical needs assessment, while desirable, was not possible within the timeframes set by federal SIP and state CA/T Mitigation deadlines. As discussed in the previous section, corridor level needs assessments are planned as part of the next update to the Boston area's Regional Transportation Plan. If necessary, the PMT would be revised to reflect newly identified needs.

A preliminary screening of each of those projects was conducted in Phase 2 to determine which projects warranted more detailed analysis. The screening was based on:

- consistency with regional, and local transportation goals, policies, and objectives.
- consistency with the intent of Intermodal Surface Transportation Efficiency Act (ISTEA) and the Clean Air Act Amendments of 1991.
- the judgments of the agency representatives that served as the PMT Update's "working committee."

This effort led to the selection of over 70 projects that were examined in detail in Phase 3. The examination of projects consisted of the estimation of ridership, operating and capital costs, fare revenue, traffic impacts, and air quality benefits. Each project was then evaluated based on a number of measures addressing utilization, cost-effectiveness, and a number of financial, air quality, and other impacts. Based on the need to fulfill SIP and CA/T requirements, and in recognition of funding availability, the most important of these considerations were the number of new transit trips that would be generated, air quality impacts, operating costs and revenues, and the capital cost per new transit rider. As detailed in this chapter, a number of those projects are recommended for implementation or for further analysis to address issues that were beyond the scope of the PMT.

Projects are also categorized as short-range or long-range projects. Short-range is considered to be through the year 2000; long range is between 2001 and 2020. ADA, SIP, and CA/T Mitigation projects have implementation deadlines. These projects have been placed in the short and long-range categories based on those deadlines. Additional expansion projects have been placed in one of the two categories based on projected funding availability (as described in Chapter 10), project benefits, and estimates of the time required for implementation.

The recommended program is summarized below and in figures 5-1 through 5-4, found at the end of this chapter. Additional details on recommended projects, by category, are provided in Chapters 6 through 9. (A detailed description of each project—both recommended and not recommended—including ridership, operating and capital costs, fare revenue, traffic impacts, air quality benefits, and associated performance measures, is provided in Appendix G.)

Preservation of the Existing System

The total replacement value of the MBTA system is estimated to exceed $7 billion. Based on the expected useful life of the individual components of the system, it would cost an average of $303 million per year to replace the existing system.[3]

On a year-to-year basis, actual costs are likely to be significantly higher or lower. This is because the life-cycle costing estimates assume that a few of each type of asset would be replaced each year. In reality, needs for an individual year depend on original construction or purchase dates, and many types of purchases, such as vehicles, are combined to take advantage of economies of scale. Also, the life-cycle estimate does not include the cost of deferred maintenance that has not yet been remedied. Finally, costs may vary when the

[3]"Building for Tomorrow: The MBTA's Capital Program FY93-FY97," November 1992.

need to replace an asset is combined with an effort to improve operations and/or upgrade the system.[4]

For the period FY 1993 to FY 1997, the MBTA has identified "infrastructure reinvestments" that total $1.22 billion. This will represent an average annual expenditure of $244 million. Major projects include a new Boston Engine Terminal ($92 million in the FY93–FY97 time frame), Blue Line station modernization ($238 million), Red Line vehicle procurement ($118 million) and systemwide fare collection equipment ($100 million). (For the complete list of projects for the period FY 1993 to FY 1997, see Chapter 6). Beyond 1997, most individual maintenance projects have not yet been selected.

ADA-Related Projects

To meet ADA requirements, the MBTA will need to spend approximately $1 billion over the next 20 years. Many of these costs will be included within the cost of other projects (such as Blue Line Modernization and new service projects). However, a large portion of these costs will be reflected in new projects specifically intended to make the system accessible. These costs are as listed in Table 5-1.

Table 5-1
ADA-Related Capital Costs
(All figures in 1993 dollars)

	Total Cost	FY 1993-FY 1997	Beyond FY 1997
Key Station Plan	$242.9m	$42.5m	$200.4m
Other Red Line Access	$3.6m	$3.6m	$0.0m
Other Orange Line Access	$11.8m	$9.7m	$2.1m
Commuter Rail Accessibility	$2.7m	$2.7m	$0.0m
Green Line Vehicles	$319.5m	$105.8m	$213.7m
RIDE Vehicles	$1.8m	$0.8m	$1.0m
Misc	$5.6m	$0.4m	$5.2m
Total	$587.9m	$165.5m	$422.4m

Note: Blue Line accessibility costs are included in the Blue Line Modernization project, and all bus accessibility costs are included in the purchase of new buses.

SIP and CA/T Mitigation Service Expansion Projects

Nearly all of the SIP and CA/T service improvement projects have merit in terms of new ridership, VMT reduction, cost-effectiveness, and air quality benefits. With the possible

[4]For example, the Blue Line modernization program consists of infrastructure reinvestment required solely to maintain the existing line, as well as expansion in that platforms will be lengthened to accommodate six car trains. Similarly, some expansion programs can take the place of infrastructure reinvestment needs. An example of this would be new maintenance and/or layover facilities built in conjunction with extensions that would eliminate the need for existing facilities.

exception of four projects—Green Line Arborway restoration, 400 buses, the Newburyport commuter rail extension, and two commuter boat facilities—and assuming that sufficient funding is available, all are worthy of implementation consistent with SIP and CA/T mitigation requirements, based on their ridership, air quality benefits, and cost-effectiveness.

If a SIP or CA/T Mitigation project is found to be infeasible for cost or other reasons, another project that would provide similar ridership and air quality benefits can be substituted. EOTC, the MBTA, and the CA/T Project are now addressing funding issues related to SIP and CA/T Mitigation projects. Since those discussions are still ongoing, substitutes for SIP and CA/T Mitigation projects are not recommended at this time. However, based on the outcome of these discussions, some substitutions may be necessary or desirable. In this case the following four projects would be the most likely candidates for substitution:

400 New Buses The purchase of 400 new buses is a CA/T Mitigation project intended to "expand peak hour capacity to 12,000 passengers in each direction." As discussed in more detail in Chapter 8, this requirement lacks clarity and does not specify the types of services that were to be provided with these buses. At the beginning of the PMT process, a number of efforts (as described in the Phase 1 and Phase 2 reports) were undertaken to identify the potential for new transit services. These efforts led to the development of the bus alternatives described in this report and the appendices. Of those that were examined, the recommended new services would require 47 new buses, be utilized by 19,980 riders per weekday, and increase total transit ridership by 9,250 trips per weekday.

Moreover, the cost to purchase and operate 400 new buses would be very high. Capital costs would be $80 to $88 million. Then, if the buses were used only to provide weekday peak period service (seven hours per day), operating costs would increase by $66.7 million per year. If the buses were in service for longer periods (for example, from 6:00 am to 11:00 pm), and on weekends, operating costs would increase by $288.5 million per year. Using the current farebox return rate for bus services of approximately 22 percent, the operating deficit would increase by $52 to $225 million per year.

Given the high costs, and that new services that would fully utilize 400 buses could not be identified, the substitution of the bus service improvements recommended in the PMT should be considered. These include better downtown Boston bus distribution and three new express bus routes (as described in the "New/Improved Express Bus Services" and "Better Downtown Boston Bus Distribution" sections of Chapter 9). The capital costs of these two projects, at $6.1 million and $11.3 million respectively, would be significantly lower than for 400 buses, while providing significant increases in bus ridership.

Newburyport Commuter Rail Extension A Newburyport extension would have a capital cost of over $40 million, would carry 1,640 total riders (including 1,440 new transit trips), and reduce regional emissions by 0.04 percent. Similar ridership increases and air quality benefits could be achieved in the same corridor by improving service on the existing Rockport/Ipswich Line. As described in detail in Chapter 9, the institution of more frequent service, express trains, and higher maximum operating speeds, at a cost of $18.6 million, would attract 2,150 total riders (including 1,460 new transit trips), and also reduce regional emissions by 0.04 percent.

Green Line Arborway Restoration The PMT analysis indicates that while the restoration of Green Line service to Arborway would constitute a significant service improvement for existing riders, it would have a negligible impact on air quality. In this respect, it would be candidate for substitution as a SIP project, since many other projects in the recommended program could provide greater air quality benefits.

Whether or not the substitution of another project for Arborway restoration is made for SIP purposes, however, this project (or an alternative) should continue to be pursued. When service was suspended in 1985 due to Green Line construction and Huntington Avenue reconstruction, the MBTA made a commitment to restore service after construction had been completed. Subsequent passage of ADA now requires that restored service be accessible, which presents a number of complications for in-street operations. This, in turn, led to the consideration of trackless trolley replacement service in the PMT analysis, in addition to the evaluation of light rail restoration.

Total ridership would be high on either restored light rail, or a trolley bus replacement, service would be significantly more convenient for existing riders, and operating costs would be reduced by up to $2.6 million per year. Based on the potential passenger and operating cost benefits, and the MBTA's existing commitment to service restoration, Arborway Restoration/Replacement should continue to be considered as a high priority project. However, further study of alternative services using criteria specifically suited to the unique characteristics of the corridor also should be conducted.

Two Commuter Boat Facilities Massport and the CA/T project have recently initiated a study of ferry services that will be more comprehensive than the PMT analysis. If that study is successful in determining a more effective manner of operating new ferry services, the new commuter boat facilities may be warranted. If not, a substitution should be considered. Better downtown bus circulation and/or improvements to commuter rail service (on the Rockport/Ipswich, Haverhill/Reading, Lowell and Franklin Lines) would be potential alternate projects that would remove traffic from downtown Boston streets.

The estimated cost of implementing SIP and CA/T Mitigation service expansion projects,[5] without substitutions, is at least $1.6 billion (see Table 5-2). With substitutions, costs would be lower.

Additional Expansion

System expansion would attract new transit riders as well as meet future travel demand. However, due to the high cost of preserving the existing system, meeting ADA requirements, and implementing SIP and CA/T Mitigation projects, the availability of the additional funding that would be necessary for additional expansion is uncertain. This is especially true in the short-term.

Projects that would generate the highest number of new transit trips, be the most cost-effective in attracting new ridership, and improving air quality, are recommended as "Additional Expansion" projects, with implementation subject to funding limitations. Projects in this category would provide different levels of benefits and are at different stages of project readiness. To reflects this, these projects, which are listed in Table 5-3, are presented in four categories:

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[5] Not all SIP and CA/T Mitigation projects are service expansion projects. Two required projects—New Red Line Vehicles and New Orange Line Vehicles—are included under the category of Preservation of the Existing System.

Table 5-2
SIP and CA/T Mitigation Service Expansion Projects (without substitutions)
(All figures in 1993 dollars)

	SIP	CA/T Mitigation	Capital Cost
Short-Term			
Old Colony Commuter Rail Restoration			
Plymouth and Middleborough Lines (underway)	√	√	$480.0m
Greenbush Line	√	√	$80.0m
Worcester Commuter Rail Extension	√	√	$119.0m
South Boston Piers Transitway	√	√	$355.9m
Washington Street Replacement Service		√	$40.0m
400 Buses		√	$88.0m
10,000 Additional Parking Spaces by 12/31/96	√	√	$0.0m[6]
10,000 Additional Parking Spaces by 12/31/99	√	√	$107.0m
Newburyport Commuter Rail Extension	√	√	$42.8m
2 Commuter Boat Facilities		√	TBD
Subtotal Short-Term			$1,312.7m+
Long-Term			
Green Line Extension to Medford Hillside	√	√	$88.0m
Blue Line - Red Line Connector	√	√	$137.5m
Arborway Restoration/Replacement	√		$56.6m
Subtotal Long-Term			$282.1m
Total: Short-Term + Long-Term			$1,594.8m+

Short-Term This category contains lower cost projects that could be implemented by 2000. Other than additional park and ride expansion, which is a compilation of a large number of small projects, the costs of these projects are each below $50 million. Most of these capital costs are for equipment purchases and parking construction, both of which can be accomplished relatively easily in the short run. The total cost of all projects in this category would be $254 million.

Long-Term Tier 1 This category generally contains the projects that have the potential to provide the greatest increases in transit ridership. Three of these projects—the North Station - South Station Rail Link, Inner Circumferential Transit, and an extension of the South Boston Piers Transitway—are among the most expensive in the PMT. The Rail Link and Inner Circumferential Transit, as well as most other projects in this category, would require a full environmental review. Circumferential Transit would also require further study of alignment, technology, and costs. It is appropriate that these projects be considered as long-term projects because of the amount of time needed to complete the required environmental processes and the need to identify funding.

The total cost of projects in the Long-Term Tier 1 category would be $5.3 billion.

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[6]The commitment to add 10,000 spaces by 1996 can be met through a combination of spaces recently completed (1,650), and parking at new stations on the Middleborough and Plymouth Old Colony lines (6,630) and the Worcester extension (2,500). The costs for these spaces are included within the costs of Old Colony and Worcester extension projects.

Long-Term Tier 2 Projects that are included in this category ranked moderately well in terms of ridership, cost, cost-effectiveness relative to other projects, but not as well as those described as higher priority projects. The total cost of these projects would be $700 million.

Table 5-3
Additional Expansion Projects
(All figures in 1993 dollars)

	Capital Cost
Short-Term	
Commuter Rail Express Service	
Rockport/Ipswich Line	$18.6m
Haverhill/Reading Line	$39.1m
Lowell Line	$17.1m
Franklin Line	$45.8m
Attleboro/Stoughton Line	$20.8m
Inner Circumferential Bus Service	$2.3m
Expansion of Existing Park & Ride Lots (beyond SIP & CA/T requirements)	$60.4m
New Park and Ride Lots on Express Bus Routes	$2.6m
Intercept Stations along Major Highways	$30.1m
New/ Improved Express Bus Services (Newton, Waltham, Burlington, Lynnfield)	$11.0m
Better Downtown Boston Bus Distribution	$6.1m
Total Short-Term	$253.9m
Long-Term Tier 1	
Expansion of Existing Park & Ride Lots (beyond SIP & CA/T requirements)	$51.2m
Intercept Stations along Major Highways	$30.1m
Rockport/Ipswich Commuter Rail/Blue Line Connection	$9.3m
Inner Circumferential Transit Line	$1,400.0m
South Boston Piers: South Station to Boylston	$180.0m
North Station - South Station Rail Link	$3,633.0m
Needham Commuter Rail Improvements/New Stations	TBD
Green Line Improvements	TBD
Subtotal Long-Term Tier 1	$5,303.6m
Long-Term Tier 2	
Blue Line Extension to Lynn	$275.0m
Red Line to Mattapan	$54.8m
New Bedford/Fall River Commuter Rail Service	$288.0m
Commuter Rail to Millis	$66.7m
Fairmount Commuter Rail/Red Line Connection	$8.2m
New Connections to Logan Airport	TBD
Route 128 Bus Service	$7.9m
Subtotal Long-Term Tier 2	$700.6m+
Total Long-Term + Short-Term	$6,258.1m+

Summary of Recommended Program

Table 5-4 below presents a summary of the capital costs for the projects recommended above. Chapter 10, Funding/Implementation, contains a discussion of the funds available to carry out the recommended program, as well as a schedule of implementation.

Figures 5-1 through 5-4 present a visual display of the recommended program by time period and geographical area. Not all of the projects could be easily represented on the maps, especially the infrastructure reinvestment projects and vehicle purchases. The figures, though, give some idea of what the MBTA system could look like in the year 2020, if the program were fully funded.

Table 5-4
Summary of Capital Costs of Recommended Program
(All figures in 1993 dollars)

	Short-Term (1994-2000) Total Cost	Long-Term (2001-2020) Total Cost
Category		
System Maintenance	$1,700m	$6,000m
ADA-Related Capital Costs	$266m	$322m
SIP and CA/T Mitigation	$1,311m	$282m
Additional Expansion	$254m	$6,004m
TOTAL	$3,531m	$12,608m

Figure 5-1
Short-Term Program: Urban Core

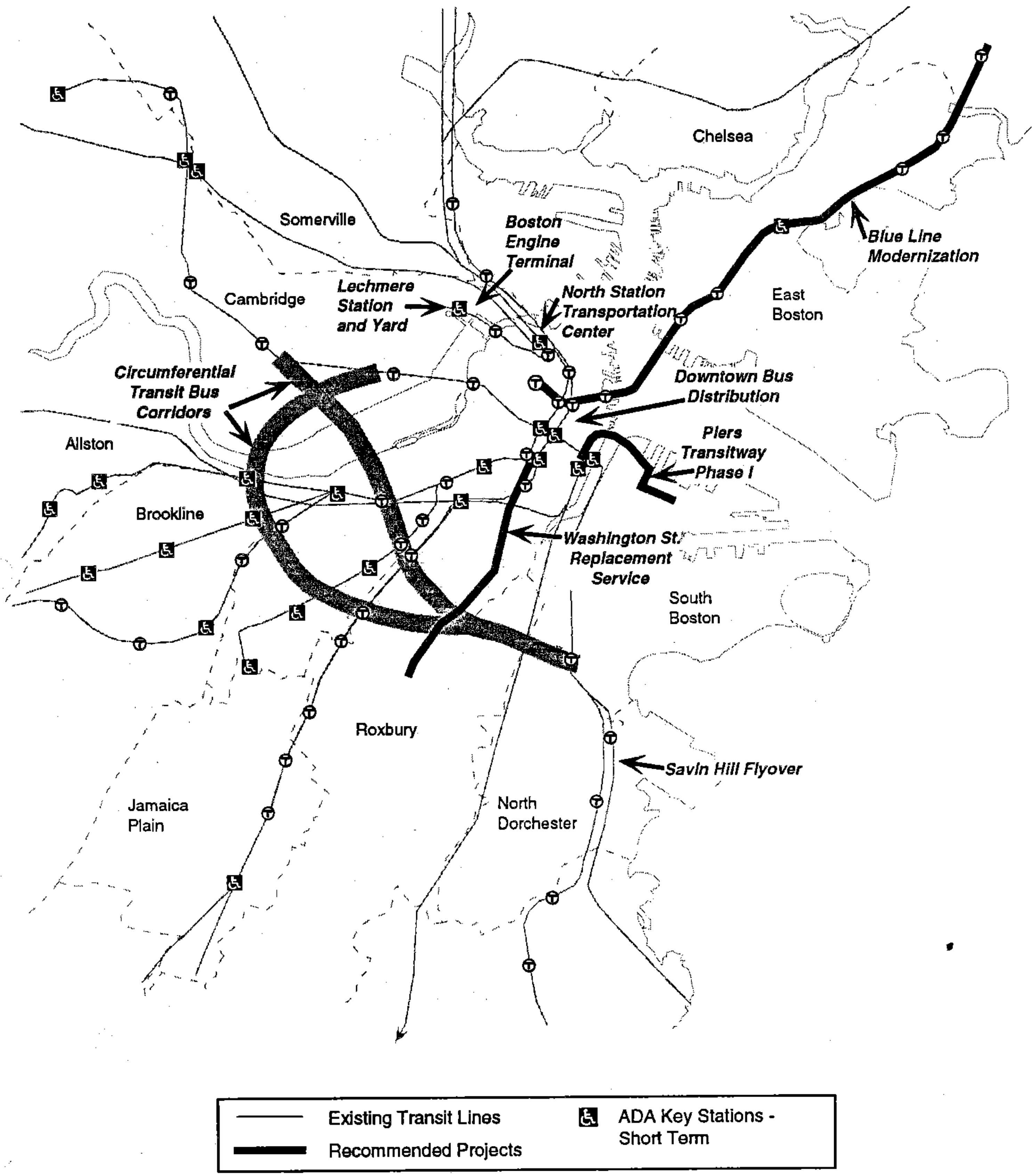


Figure 5-2
Short-Term Program: Outer Areas

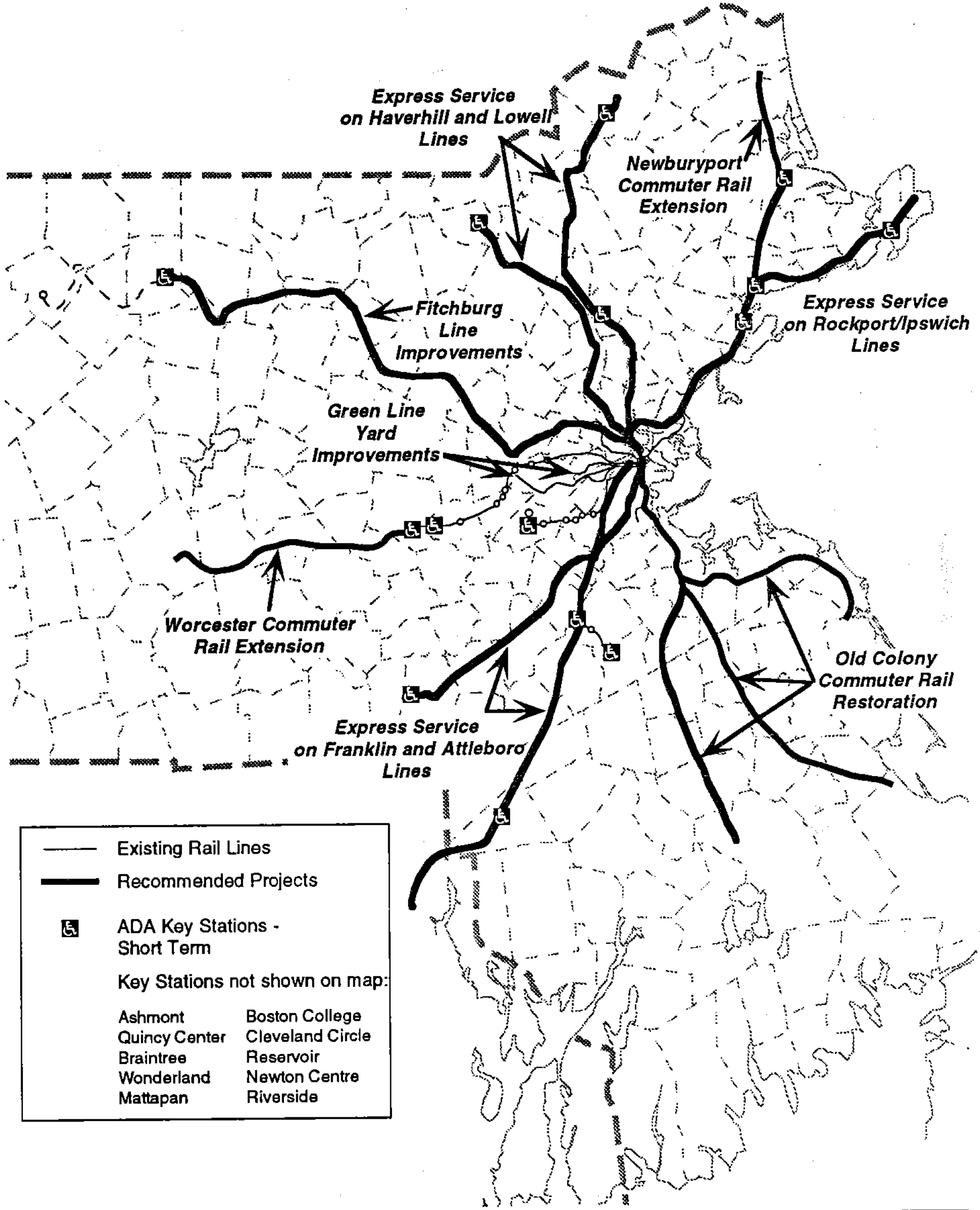


Figure 5-3
Long-Term Program: Urban Core

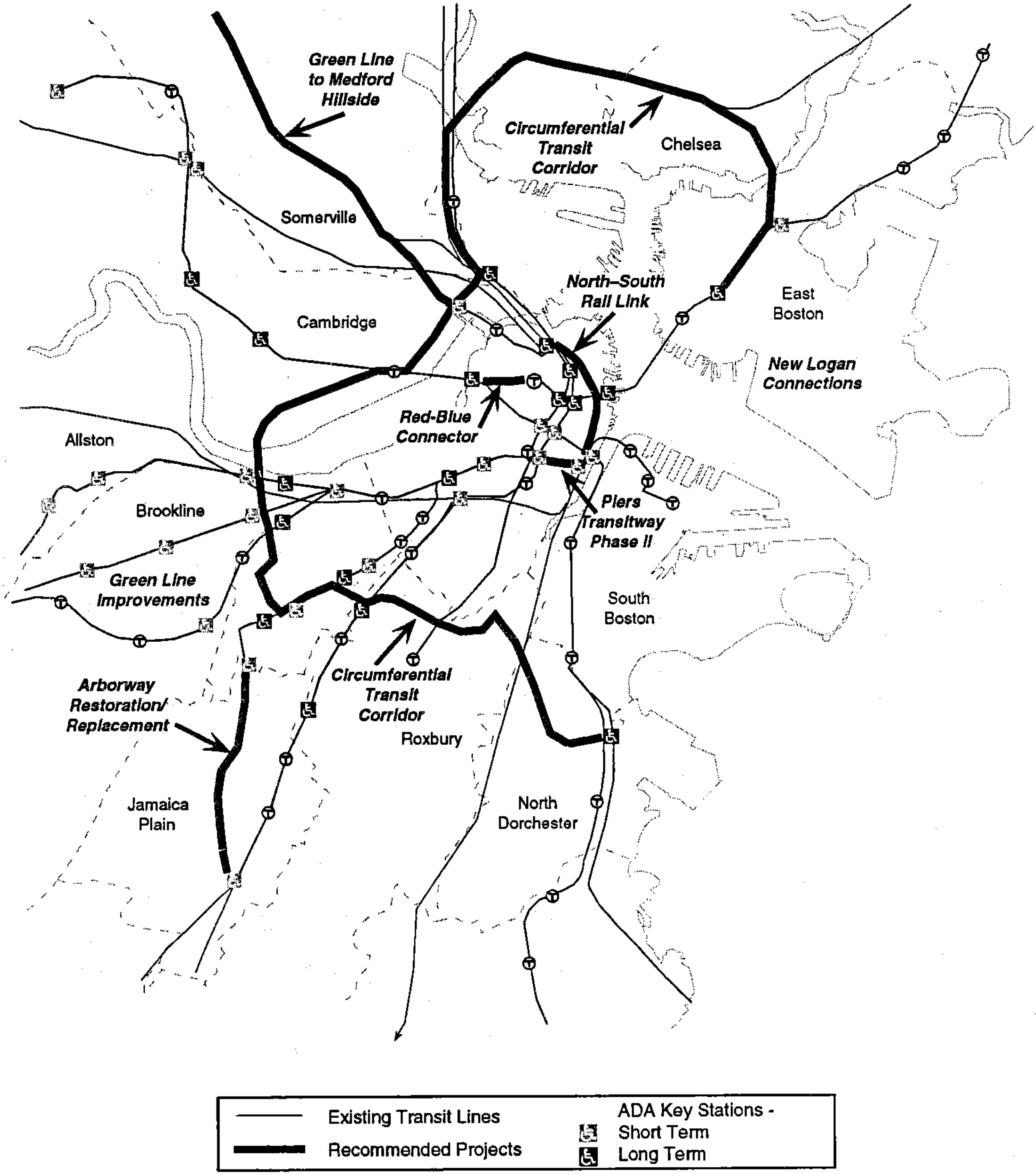
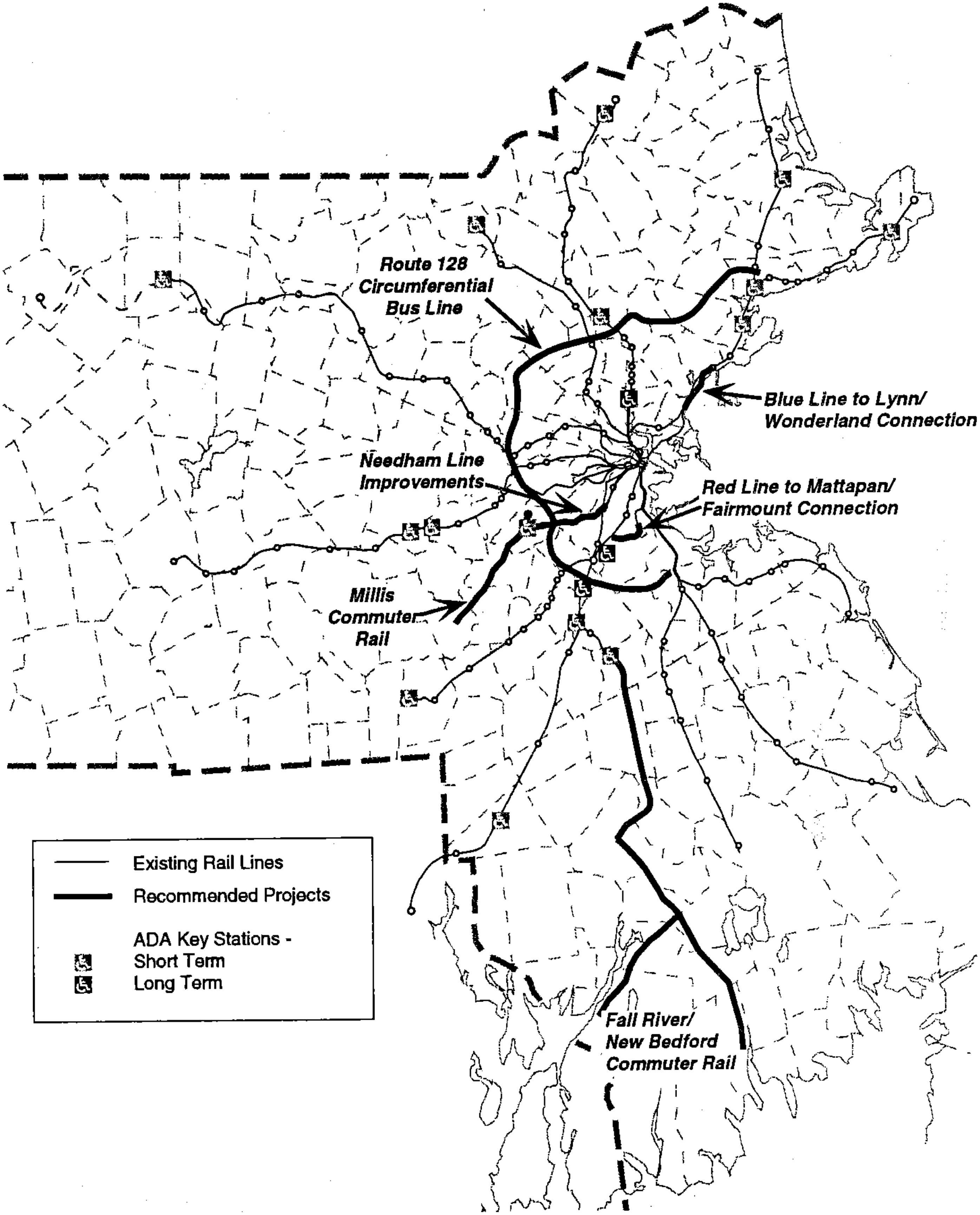


Figure 5-4
Long-Term Program - Outer Areas



Chapter 6

Preservation of the Existing System

Beginning in the 1980s and continuing today, there has been a major emphasis on improving management and labor practices, and on upgrading the system.[1] Today, most facilities and rolling stock have been upgraded, renovated, and/or replaced. During the same period, maintenance has also been improved, which has resulted in more reliable service. The result has been that ridership has grown more than 21 percent on the bus and subway systems, and more than 100 percent of commuter rail, and nine in ten MBTA customers are now satisfied with service.

While the rebuilding and expansion of the system was successful, it was expensive, at a cost of over $4 billion. To prevent the system from returning to its prior condition, and to avoid the additional costs associated with repairing problems caused by deferred maintenance, the preservation of the existing system is now considered to be the highest priority in planning for the future. This chapter documents these costs.

Life-Cycle Costs

The total replacement value of the MBTA system—rolling stock, track, tunnels, bridges, stations, maintenance facilities, etc.—is estimated to exceed $7 billion. Each component of the system will eventually wear out and need to be replaced or reconstructed. With normal routine maintenance, the expected economic "useful life" of the various components of the MBTA system ranges from four years (RIDE vans) to 60 years (tunnels and bridges). Assets such as RIDE vans, buses, and subway cars are typically replaced at the end their useful life. More permanent assets such as tunnels and buildings are usually not replaced, but do periodically require major reconstruction. Over the useful life of an asset, these costs will be similar to the replacement cost.

The MBTA has conducted a life-cycle costing analysis of its capital assets, which indicates that the theoretical cost of preserving the existing system would average of $303 million per year. These costs are summarized in Table 6-1 and detailed in Table 6-2. The life-cycle costing method used by the MBTA was based on (1) an inventory of the MBTA's capital

[1]See Appendix D for a description of these improvements.

assets, (2) estimates of the economical useful life of each type of asset, and (3) estimates of the current replacement cost for each type of asset.[2]

Table 6-1
Total and Annual Replacement Costs
($ millions)

	Total Replacement Cost	Annual Life-Cycle Cost
Vehicles Replacement & Parts	$1,795	$92
Track & Power Systems	964	56
Tunnels, Viaducts, & Bridges	1,165	29
Stations & Stops (including Parking)	1,138	58
Signals/Communications	1,084	37
Garages/Maintenance Facilities	877	19
Equipment	36	7
Buildings	247	5
Total	$7,306	$303

Source: MBTA

While the figures in Table 6-1 are useful in providing an estimate of the magnitude of system preservation expenditures in an average year, they do have limitations. Implicit within life-cycle costing is the assumption that a few of each type of asset will be replaced each year. In reality, few years are "average", and needs for an individual year may be significantly higher or lower. The major factors affecting needs for an individual year include:

- **The Age of Individual Components of the System** The age of individual components of the MBTA system is the most important factor affecting year-to-year costs. The newer these components are, the lower short-term costs will be. For example, no major reconstruction expenses are projected over the life of this PMT (through 2020) for the new Orange Line because it is only seven years old. Similarly, the restoration of South Station was recently completed, so that no major reconstruction expenses are expected. On the other hand, commuter rail's Boston Engine Terminal (BET) was allowed to deteriorate by the Boston and Maine Railroad, and the MBTA is now faced with high short-term costs to replace that facility.

  The MBTA has considered the age of equipment and facilities in identifying its infrastructure reinvestment needs over the period FY 1993 to FY 1997. As discussed in the next section, these needs are estimated at a total of $1.22 billion. This represents average annual expenditures over this period of $244 million.

[2]The proposed rules for the Public Transit Facilities and Equipment System (PTMS) required by ISTEA suggests that this type of methodology be used ("Management and Monitoring Systems; Proposed Rule," from the Federal Register, Volume 58, Number 39, Tuesday, March 2, 1993, page 12109.

Table 6-2
Average Annual Infrastructure Reinvestment Needs
($000s)

	Number	Annual Life-Cycle Cost
Vehicle Replacement		
Green Line	225	$16,200
Red Line	216	$15,390
Orange Line	120	$7,670
Blue Line	70	$4,568
Buses/Trackless Trolleys	1068	$19,613
RIDE Vans	126	$992
CR Coaches	380	$17,140
CR Locomotives	59	$5,452
Non-Revenues Vehicles	547	$1,149
Parts		$4,000
Subtotal		$92,174
Track & Power Systems		
Rapid Transit/Light Rail Track	183 miles	$13,725
Commuter Rail Track	479 miles	$35,925
ROW Fencing	172 miles	$602
Third Rail	95 miles	$1,520
Power Stations	1	$154
Substations	37	$2,590
Catenary	90 miles	$1,800
Subtotal		$56,316
Tunnels, Viaducts, & Bridges		
Tunnels	34 miles	$708
Viaducts	2 miles	$167
Bridges	400	$25,000
Vents Shafts	56	$2,800
Subtotal		$28,675
Stations and Stops (including Parking)		
Red, Blue, & Orange Lines	55	$44,000
Green Line Subway	11	$8,800
Green Line Surface Stops	81	$648
Bus Stops	10,000	$243
Commuter Rail	99	$5,148
Subtotal		$58,839
Signals/Communications		
Central Control	1	$1,667
Rapid Transit/Light Rail Track & Wayside	183 miles	$18,300
Commuter Rail Track & Wayside	479 miles	$15,967
Mobile Radios	1,050	$210
Radio Base Stations	40	$$667
Subtotal		$36,811
Garages/Maintenance Facilities		
Red Line	2	$1,470
Green Line	4	$2,520

Table 6-2 (cont.)
Average Annual Infrastructure Reinvestment Needs
($000s)

	Number	Annual Life-Cycle Cost
Garages/Maintenance Facilities (Cont.)		
Blue Line	1	$1,050
Orange Line	1	$1,050
Buses/Trackless Trolleys	8	$3,927
Commuter Rail	2	$6,800
Systemwide	2	$2,100
Subtotal		$18,917
Equipment		
Fareboxes	1,000	$400
Turnstiles	420	$218
Computer Hardware & Software		$3,500
Subtotal		$4,118
Buildings		
North Station	1	$2,600
South Station	1	$2,800
Arborway Complex	1	$1,000
Other	100	$400
Subtotal		$6,800
Grand Total		$302,650

The MBTA has not yet considered the age of individual components of its system in order to project infrastructure reinvestment costs on a year-to-year basis over the long term. It is expected that this will be done as part of the development of the Public Transportation Facilities and Equipment Plan (PTMS) that is required by ISTEA. Over the past decade, a major emphasis has been placed on rebuilding the existing system. As discussed in Appendix D, much of the existing infrastructure has recently been reconstructed or replaced. Most of these improvements have relatively long life spans (20 to 60 years). Therefore, while long-term year-to-year costs cannot be accurately projected until the age of the individual components has been fully considered, it is possible that infrastructure reinvestments needs over the life of much of this PMT may be lower than the annual average need of $303 million presented above.

- **Economies of Scale** While costs would be more consistent if an equal number of vehicles or equipment were purchased each year, larger volume orders are often more cost-effective. For example, the Blue Line fleet is relatively small (70 vehicles) and the economic useful life of Blue Line vehicles is 25 years. Maintaining consistent replacement expenditures would mean purchasing less than three new vehicles per year. The cost of doing so would be significantly higher than purchasing more vehicles less frequently.

- **Deferred Maintenance** Where equipment or facilities should have been previously replaced or reconstructed but were not, costs for a given year may be higher than average. The purchase of the large amount of commuter rail equipment in the 1980s and 1990s is an example of higher costs due to deferred maintenance. Commuter rail's Boston Engine Terminal is another example. This facility has never been upgraded and

is now poorly suited to maintaining the commuter rail fleet. Because it is so outdated, it now makes more sense to replace it rather than to try to upgrade it.

In addition, some infrastructure reinvestment needs can be eliminated by certain expansion and/or service improvement projects. For example, the construction of new Orange Line, while seen as a service improvement project, eliminated the need to incur large reconstruction expenses that would have been needed for the old elevated Orange Line.

Finally, it should be noted that system expansion will also increase long-term infrastructure reinvestment costs—as more facilities are constructed and more equipment purchased, there will be more infrastructure that will need to be maintained and replaced. The PMT analysis considered the long-term impact of new services by determining the life-cycle cost of each project.[3] However, because the life span of most components of expansion projects are in the range of 20 to 60 years, the impact of current and planned expansion projects on infrastructure reinvestment costs will largely be incurred beyond the timespan of this PMT.

FY 1993 to FY 1997 Identified Needs

For capital planning purposes, the MBTA categorizes infrastructure reinvestment projects as those that fall into one or more of the three categories. These are:

(1) Remedial Replacement Projects for which economic or other investment decision criteria dictate replacement should already have occurred but had been deferred. The Boston Engine Terminal and the oldest Red Line cars are examples of this type of expenditure.

(2) Periodic Replacement Projects where life-cycle and other investment decision criteria dictate that an asset should be replaced or renovated. The MBTA's bus replacement program, which is intended to keep the average life of the bus fleet at six years, is an example of periodic replacement.

(3) Replacement and Improvement The need to replace an asset is often combined with an effort to improve operations, upgrade the system, and/or to expand service. The largest example of this type of improvement is the Blue Line modernization program, which consists of approximately 50 percent reconstruction and 50 percent service expansion.

Based on these definitions, the MBTA has identified a total of $1.22 billion in projects that are needed for infrastructure reinvestment purposes over the period FY 1993 to FY 1997. These projects are summarized in Table 6-3 and described below.

Bus/Trackless Trolley

Bus system infrastructure reinvestments needs consist of the replacement and rehabilitation of buses and maintenance facility upgrades.

Bus Procurement

This is a purchase program designed to reduce the average age of the bus fleet to six years, while upgrading the system with buses that meet Federal and State Clean Air and ADA

[3]This is listed as the "Annualized Capital Cost" in Table G-1 in Appendix G.

Table 6-3
Cost of Identified Infrastructure Reinvestment Projects

	Total Project Cost	FY 1993-FY 1997
Bus/Trackless Trolley		
Bus Procurement	$110,000,000	$110,000,000
Bus Retrofit/Rehabilitation	$61,168,599	$56,186,576
Maintenance	$8,822,837	$657,033
Dudley Station	$9,185,000	$5,759,425
Commuter Rail		
Right-of-Way/Track/Signals/Communications	$36,542,367	$9,810,405
Bridges	$23,153,833	$3,774,655
Terminals/Stations/Park-&-Ride/MOW HDQRS	$66,736,885	$4,124,888
Boston Engine Terminal	$102,299,795	$91,796,476
Vehicle Rebuild	$40,243,945	$24,146,509
Vehicle Procurement	$154,820,060	$23,452,686
Service & Inspection Facility	$47,333,183	$13,905,516
North Station Transportation Center	$143,000,000	
Other	$111,869,166	$17,220,416
Blue Line Modernization		
Power Upgrade	$36,640,000	$36,023,710
Station Modernization	$361,883,311	$237,702,845
Track/Signals/Communications	$49,800,836	$5,478,384
Bridges	$1,050,960	$879,094
Vehicle Procurement	$70,000,000	$24,000,000
Green Line		
Power Upgrade	$73,420,904	$5,028,691
Station Modernization	$9,787,199	$5,537,420
Right-of-Way/Track	$182,901,775	$13,365,593
Lechmere Station	$58,000,000	
Riverside Yard Improvements/Facility	$39,187,587	$37,070,562
Vehicle Procurement	$11,374,327	$431,895
Ventilation Shafts	$14,300,628	$2,137,875
Red Line		
Station Modernization	$53,929,644	$14,694,163
Maintenance & Management Facilities	$2,577,247	$1,783,722
Ventilation Shafts	$14,564,117	$11,773,089
Power Upgrade	$2,408,500	$2,339,794
Track	$635,606,724	$9,489,930
Vehicle Procurement	$153,912,107	$118,060,959
Bridges	$12,200,000	$12,199,005
Orange Line		
Vehicle Procurement	$131,000,000	
Systemwide		
Fare Collection Equipment	$137,446,194	$100,029,391
Plant & Power Improvements	$136,642,528	$19,173,446
Tunnels	$52,368,749	$5,705,219
Bridges	$57,250,965	$35,888,802

Table 6-3 (cont.)
Cost of Infrastructure Reinvestment Projects: Identified Projects

	Total Project Cost	FY 1993-FY 1997
Systemwide (Cont.)		
Non-Revenue Equipment Procurement	$41,327,515	$3,230,194
ISS Program	$33,428,932	$10,151,983
Noise Mitigation	$10,000,000	$8,700,000
New Police Station	$10,000,000	$5,947,041
Operations Control Center	$48,654,139	$45,013,127
South Boston Power Plant/ Cardinal Medeiros Pier	$3,810,539	$2,751,759
Other	$220,585,396	$87,038,360
Total	$3,591,236,493	$1,222,460,638

standards. Fleet expansion is viewed as a flexible mitigation tool for the Central Artery/Tunnel construction. The MBTA purchases buses on a yearly and bi-yearly basis and is currently purchasing 200 replacement buses as part of its ongoing program to upgrade system capacity. The new buses will begin to arrive in March of 1994. These vehicles will replace the oldest vehicles in the fleet, reducing the need for costly repairs. The authority has an option to purchase an additional 180 buses, as well. Procurement funding for 200 buses, totaling $110 million, is in the current five year spending plan. The current price for a new bus is approximately $200,000.

Bus Retrofit/Rehabilitation

The project is intended to improve reliability, achieve compliance with Federal and State Clean Air and ADA standards, and increase the flexibility of Central Artery/Tunnel mitigation response by ensuring that the current fleet is in top condition. Over the next five years, 400 buses are expected to be rehabilitated in two phases, a mid-life overhaul of 200 buses, and an additional rehabilitation of 200 more.

Maintenance

As the MBTA invests in new bus technology consistent with Clean Air Act and ADA requirements, maintenance facilities must be equipped to support the upkeep of these vehicles. Improvements include installing new heating systems, electrical modifications, roof replacements, and site improvements. Periodic improvements are needed over the next five years at Bartlett, Lynn, Fellsway, Cabot, and Charlestown. Currently programmed projects include a rehabilitation of the Albany garage and the Boston University Bridge.

Dudley Station

This project consists of the conversion of the old Dudley Orange Line Station into a multimodal bus facility. It will move bus service from Warren and Dudley Streets into the station proper. Currently the MBTA is replacing stolen and storm damaged copper roofing and ornamentation in consistent design with historical detail. Completion of the project is expected in 1993.

Commuter Rail

Right-of-Way, Track, Signals, & Communications

The MBTA has targeted the rehabilitation of approximately 200 miles of right-of-way to install double tracking and mitigate drainage problems on the Haverhill and Fitchburg Lines. The Haverhill Line is restricted by clearances, substandard and/or deteriorated bridges, and degraded track conditions, preventing the use of new locomotives and double-decker passenger coaches on this line. While vertical clearance of the Wellington tunnel roof is being increased, the Corporation Track at the Wellington Tunnel is being used as a temporary by-pass track. Clearance restrictions are being eliminated at Malden Center, Oak Grove, and Clifton/Washington St in Malden. The track between Foley Street and the Fells Interlocking is being rehabilitated.

Construction of new track, track modification, and relocation will be required in the area around the new Service and Inspection facility in South Boston. New signal and signal circuit modifications linking the facility to South Station and Southampton and Fan Yards will also be required.

Bridges

Signal and bridge improvements are needed on the Lowell and Dorchester Branches. Railroad bridges in Medford, at Medford St and Mount Pleasant St, are being upgraded to achieve locomotive loading requirements.

Terminals/Stations/Park & Ride/MOW Headquarters

This project involves improvements to terminals in Lowell and Framingham, enhancement of the Lynn Station and Garage, work on a Merrimack Valley RTA Station, construction of park and ride facilities for northside and southside service, and work on the Maintenance-of-Way headquarters on the north and south sides. In addition, rehabilitation of dilapidated stations such as the Newton stations on the Framingham Line is anticipated.

Boston Engine Terminal

The Authority is currently examining options for financing a new terminal. The existing engine terminal was built over 60 years ago and is poorly suited for maintaining the commuter rail fleet. The project includes a total reconstruction of the areas used to maintain and store MBTA coaches and locomotives. Capital plan spending would cover design, utility relocation, land acquisition, site work, demolition, track and signal work, and new construction phasing. The MBTA has contracted for signal and communications work and construction of a 4 track layup yard for the relocated track on the Fitchburg main line at Yard 14. Track switches, signals and snow melter systems will be remote controlled at the commuter Rail Maintenance facility. A dispatcher telephone system, a wayside maintenance phone system and an upgrade of the existing radio system will also be installed.

Vehicle Rebuild

The MBTA is conducting a mid-life overhaul of 57 Pullman coaches, to update the major component parts, such as mechanical systems, truck assemblies, and wiring. Completion of this project is scheduled for 1995. The estimated cost per car is anticipated to be over $450,000 for a mid-life overhaul.

Service & Inspection Facility

In connection with the Old Colony extension project, the MBTA is constructing a new Service and Inspection facility for daily servicing, inspection, and light maintenance of

commuter rail rolling stock utilizing the South Side rail system. The facility is bounded by the Cabot substation and bus garage, South Station, Quincy Cold Storage, and Southampton Yard. Initial track access limited activities to five train sets per day.

The project includes the construction of a new building and new track, track modifications and relocations to provide more access options to the facility, and signal and utility modifications to provide links between the Service and Inspection facility, South Station and the Southampton and Fan yards. This work is expected to increase the number of train sets serviced per day to 15. Track work and major signal redesign at Cabot Yard is also underway, to provide space for the service and inspection facility, which will include a new retaining wall, a new test pit, two new 250,000 gallon fuel storage tanks and a pedestrian bridge.

North Station Transportation Center

The project is a cooperative venture involving the MBTA, the City of Boston, and the developer of the new Boston Garden. Project features include construction of a 1,300 car underground parking garage, new high-level platforms at the commuter rail terminal improving accessibility for all passengers, depression of the Green Line into a tunnel, and construction of a Green Line/Orange Line super-station, providing direct, underground access to and from the commuter rail.

Other

This is a series of projects targeted at systemwide improvements and enhancements, including station lighting, the commuter rail safety and enhancement program, and maintenance equipment procurement.

Blue Line Modernization

This project will rehabilitate all Blue Line stations, track, power, and signal systems, to make stations accessible to the disabled and more structurally sound, provide better passenger security and amenities, improve Logan Airport access, increase line capacity, and improve service reliability and passenger safety.

Station platforms will be lengthened at State, Suffolk Downs, and Wonderland stations to accommodate six-car trains. At all stations, elevators and ramps will be installed, to provide access to passengers with disabilities. New fare collection and passenger waiting areas with improved lighting, benches, and informational signs will be constructed. Two new entrances to Government Center station will be built, providing access from Center Plaza and Government Center Plaza. Two new entrances to State Street Station will also be built. A new entrance to Aquarium station will be built on the downtown side of the Central Artery, near Quincy Market. The tunnel at Maverick station will be waterproofed, and unused platforms will be restored.

The modernization plan also includes design and procurement of 35 new Blue line cars, which is necessary before a Blue Line fleet mid-life overhaul program is implemented after 1995. Expansion of the fleet will result in additional maintenance costs once vehicles are off warranty. Operating costs for the new cars will include minor increases in power requirements and cleaning efforts.

The MBTA has identified the need to renovate and upgrade track from Bowdoin through Orient Heights stations, install new ventilation shafts at Maverick, and upgrade signals and communications equipment on the entire line. The improvements will help the line operate

more efficiently, and improve fire safety. The deteriorating elevated structure of Beachmont station will be totally rebuilt. The Orient Heights Yard and Carhouse will be renovated to improve maintenance and operating efficiency.

Green Line

The design of the Green Line reflects its status as the oldest subway in America. This light rail system faces particular challenges in scheduling to provide acceptable waiting times for passengers at the outer branches, while managing traffic flow at the convergence point downtown. Its street level design requires interface with automobile traffic on congested city streets.

Power Upgrade

This is a current project to upgrade traction power on the Green Line for an increase in capacity and greater efficiency. The work will improve the Green Line's Central Subway portion of the Beacon Street Branch, enabling it to be separate from the Highland Branch. Improvements to the catenary system and substation equipment from Kenmore and Huntington portals to the Lechmere Tunnel will allow revenue vehicles to operate at increased service levels, and greatly reduce disruption failures.

Station Modernization

As part of the MBTA's station rehabilitation program, several stations are being worked on to improve station appearance and customer waiting experience. Particular improvements include lighting, collectors' booths, signage, benches, paintings and replacement of doors and windows, and stairtreads.

Right-of-Way, Track, Signals

Improvements are necessary to the existing infrastructure of track, and signals, to correct for deferred maintenance and maintain existing service levels. Yard improvements are needed at Riverside, Lake Street and Cleveland Circle. Track improvements are programmed for the Beacon Street Line and the Highland Branch to eliminate speed restrictions and speed service. Structural steel beams and columns between North Station and the Haymarket portal are being rehabilitated to provide supplementary support to the overhead track structure.

Lechmere Station and New Green Line Maintenance Facility

The first phase of this project would be the relocation of Lechmere station, in conjunction with a Green Line extension to Medford Hillside. Total cost for the station relocation is anticipated to be $58 million.

The second phase of the project would be construction of a new Green Line maintenance facility at the new Lechmere station. This would improve the operations by providing maintenance near the northern terminus of the Green Line. The facility would provide needed storage for 50 to 60 vehicles.

Riverside Yard Improvements

The Riverside Yard Rehabilitation Project has several components. Outdated and service worn track which presents a potential derailment safety problem is being replaced. A new track configuration is being constructed, using continuous welded rail, new crossties and ballast, to improve running times by changing the means of shifting trolleys through the track geometry, which currently requires the trolleys to traverse the perimeter of the yard.

The signal and catenary system will be upgraded. A new passenger platform with a canopy and handicap accessibility will be built. The parking lot will be reconstructed, including new paving, curbing, lighting, drainage, a new lot entrance, a designated express bus lane, a management facility, a sanding and vaulting facility, landscaping, a new unit substation, and renovation of the existing intercity bus terminal.

Vehicle Procurement

The MBTA is planning to purchase 100 low floor cars to replace the Boeing Green Line vehicles. For more information, see Chapter 7.

Ventilation Shaft

As part of its ongoing vent shaft project, the MBTA has contracted for design and engineering services for vent shafts G-8 through G-11 on the Green Line. These shafts will provide ventilation and fire safety to the heaviest travelled section of the Green Line Subway, from Park Street to Copley Station. Current work will provide design services showing vent shaft location at 163-167 Tremont Street, engineering and architectural construction plans, an updated tunnel survey, a soils investigation, and land acquisition plans. Completion of this design work is expected for January 1994.

Red Line

Station Modernization

This project consists of improvements to various Red Line Stations, including Andrew Station and Broadway Station, to improve station appearance and customer waiting experience. Particular improvements include lighting, collectors' booths, signage, benches, paintings and replacement of doors and windows, and stairtreads. Most of the work in these stations is nearly complete, though there are minor projects still in progress.

Maintenance and Management Facilities

The MBTA's maintenance facilities require expansion at Codman, Cabot, and Mattapan, to accommodate the new vehicles coming into service between 1993 and 1995. Existing pits and maintenance equipment need modifications to accommodate present day operations. Fuel tanks at Cabot Garage are currently being relocated. Also, as Central Artery improvements are constructed, such as the South Boston Haul Road, and the Fort Point Channel rail bridge, additional improvements may be necessary at Cabot Yard to provide direct access to the Haul Road for buses and to realign the turn-around loop for the trains.

Ventilation Shafts

Construction of three vent shafts near Broadway and Andrew Stations is underway and is scheduled for completion by the end of 1993. One is located in the Cabot Yard, at the corner of Dorchester Avenue and West Fourth Street. Another is located at the corner of Dorchester Ave and D Street. A third is located at Boston Street, opposite St Mary's School.

Track, Power, Signals

This project consists of improvements to the Red Line from Harvard to Alewife, track and station rehabilitations and improvements, and rehabilitation of the Cabot substation.

Vehicle Procurement

The MBTA needs to both replace and expand its Red Line fleet. Procurement began in 1991 for 86 new Red Line cars, to replace the Bluebird cars purchased in 1963 and rebuilt

through 1984. Replacement of these cars will eliminate costly maintenance efforts, and improve reliability of the service. Need for an additional 56 cars has been identified through the Central Artery Mitigation process, which would serve to expand the fleet and service capacity.

Bridges

The MBTA is repairing bridge and abutment structural components of the Savin Hill flyover and the Anderson Bridge because of the deteriorated state of the direct fixation rail fastening system and rail expansion joints on the flyover. Signal improvements are needed at Columbia. Without these repairs, the condition of the Savin Hill flyover could dramatically decrease train speeds at Savin Hill, disrupting operations and schedules on the Red Line. Project components include modification of the flyover to allow for a ballasted deck, standard crosstie and ballast track construction, and relocation of the rail expansion joints. A temporary cutover of the South Shore extension to the Cambridge–Dorchester line will permit uninterrupted service during reconstruction.

Orange Line

Vehicle Procurement

The MBTA plans to procure 46 new Orange Line vehicles to meet future demand. Ridership on the Orange Line has grown significantly since the opening of the Southwest Corridor. Reconstruction of the Central Artery is expected to result in additional ridership demand. Procurement of the new vehicles will enable a mid-life fleet overhaul program after 1995. Funding for procurement of the new cars will be identified when design becomes final. Anticipated total cost is estimated at $131 million.

Systemwide

Fare Collection Equipment

In order to improve fare collection and ridership information, $100 million has been earmarked for a complete upgrade of fare collection equipment throughout the system, over the next five years. Outdated fare collection technology currently in place is not equipped to provide accurate accounting of ridership on the system, limiting the ability to make marketing and fare structure decisions. The electronic fareboxes will replace the 30 year-old mechanical fareboxes in use in all buses and Green Line cars.

Plant & Power Improvements

To increase the reliability and safety of the power and communications systems, the MBTA plans to upgrade AC cable and conduit systems and to continue to repair and upgrade the 55 substation network which provides power for vent fans, lighting, fare collection, signal systems and fire detection. Installation of new third rail heaters on the Orange and Red Lines is also included.

The MBTA also plans procurement of a second combustion turbine engine, to be installed at the South Boston complex. The new engine will increase the backup capability of the electrical power generation system, enabling continuous operation of trains and trolleys in the event of Boston Edison power disruption. The engine would also provide standby power capacity available for sale to regional power companies during periods of high regional electric load or emergencies, reducing the cost of power to the operating budget. The Final Environmental Impact Report was submitted on March 1, 1993 to the Massachusetts Environmental Protection Agency.

Tunnels
This project consists of improvements to and rehabilitation of the supervisory vent network, systemwide tunnels and tunnel vents, and the pump rooms. The MBTA's pump rooms, which drain the subway tunnels, keeping them from flooding, are in need of reconstruction and new equipment. They date back to the subway construction period and have had little electrical and mechanical modernization since then. Currently pump rooms at Prudential, Symphony, Walnut, A street, Andrew, east of Kendall, east of Central, Haymarket and Beach street are under construction to upgrade their structural condition and mechanical equipment.

Bridges
The MBTA, in compliance with Federal legislation (ISTEA) is undertaking a systemwide bridge rehabilitation program, scheduled for completion by the end of 1995.

Non-Revenue Equipment Procurement
Procurement of non-revenue maintenance vehicles and equipment will provide support for heavy construction activities, power and signal maintenance efforts, snow removal and emergency response. Vehicles and equipment will be purchased for the MBTA Police Department, the Transportation Department, and Marketing and Communications. The vehicles will replace the oldest non-revenue vehicles, reducing maintenance costs and eliminating expenses for vehicle leasing.

ISS Program
This project consists of the purchase of new computer hardware and software to replace outdated equipment and expand automation to new areas, including an automated financial management system and materials for encoding systems to replace manual systems. The MBTA is currently upgrading all of its management information systems, many of which are either entirely manual or based on decades-old technology. Systems efforts underway include materials tracking, construction scheduling and payment, operations scheduling programs, and maintenance reporting.

Noise Mitigation
This project involves the installation of noise barriers to mitigate noise impacts on neighborhoods along rapid transit lines. Currently, the MBTA is addressing operations related noise problems in the Southwest Corridor. Northeastern University has conducted a noise study, and found that noise and vibration levels in the corridor exceed the November, 1985 construction project agreement. The MBTA will mitigate noise and vibration related damage to University buildings resulting from operation of trains and transit vehicles in the corridor. Similar efforts are anticipated for the Blue Line Modernization program.

New Police Station
The MBTA has plans for relocating its Police Station into a building better tailored to the needs of the police force. The current Police Station at the Cabot Yard Red Line maintenance facility is a former administrative building which does not contain the necessary facilities for a police station. The current layout creates safety problems as prisoners must walk up three flights of stairs for booking and both the public and prisoners must use the same approach to enter and leave the building. There are only three holding cells, creating difficulties whenever more than three people are arrested at one time. There are no interview/interrogation rooms, and there is inadequate space for secure evidence and property storage. The new station will correct these operational deficiencies and ensure the safety of MBTA Police officers and apprehended prisoners.

Modernization of the Operations Control Center at 45 High Street

Operations of each subsection of the MBTA system are electronically monitored in real-time, with links to every reporting station and surface terminus 24 hours a day. Specific responsibilities include station-level public address service information announcements, real-time evaluation of vehicle availability and schedule adherence, and coordination of alternate service provision to manage disruptions in daily service.

This project will add five stories to the building, providing space for a double-level floor for the new Operations control room, two floors of offices and a floor for employee facilities. Fire protection, mechanical systems power conditioning, and access for persons with disabilities will all be improved. The Control room will house the Supervisory Control and Data Acquisition System, which will have a computer-generated system overview display using rear-projection video, high resolution color graphics CRTs at individual work stations. All major computer systems will be consolidated into a single system on the fourth floor, including a computerized central train control (CTC) system with database management and modification capabilities for managing the controlled territory field communication systems, and a distributed processing interface between field data transmission and communications.

The secondary control center at Park Street Station will be retained, with an upgraded communications capacity.

South Boston Power Plant

The MBTA has contracted for design of improvements to the South Boston Power Plant Piers, to maintain and protect its equipment and property and eliminate the possibility of marine traffic restrictions through the Reserve Channel. This project will also include repairs to the Cardinal Medeiros Pier area.

Other

Many projects are included under this category, such as Interagency Agreements, Planning and Development, mini-improvements to stations, operation, maintenance and upgrade of over 200 fire alarm systems, and miscellaneous plant, infrastructure and other concerns. The MBTA also makes continue effort to respond to environmental hazards, such as PCB transformers, asbestos removal, and waste oil management. While each capital project anticipates spending on environmental remediation in overall estimates, this proposed spending would allow for a continuation of additional environmental efforts.

Chapter 7

Accessibility Improvements

The MBTA Rapid Transit system is the oldest in the country and, until 1977 with the opening of Oak Grove Station on the Orange Line, was not built to be accessible to people with disabilities. Since then, the system has been undergoing a slow conversion to full accessibility through station renovation and modernization.

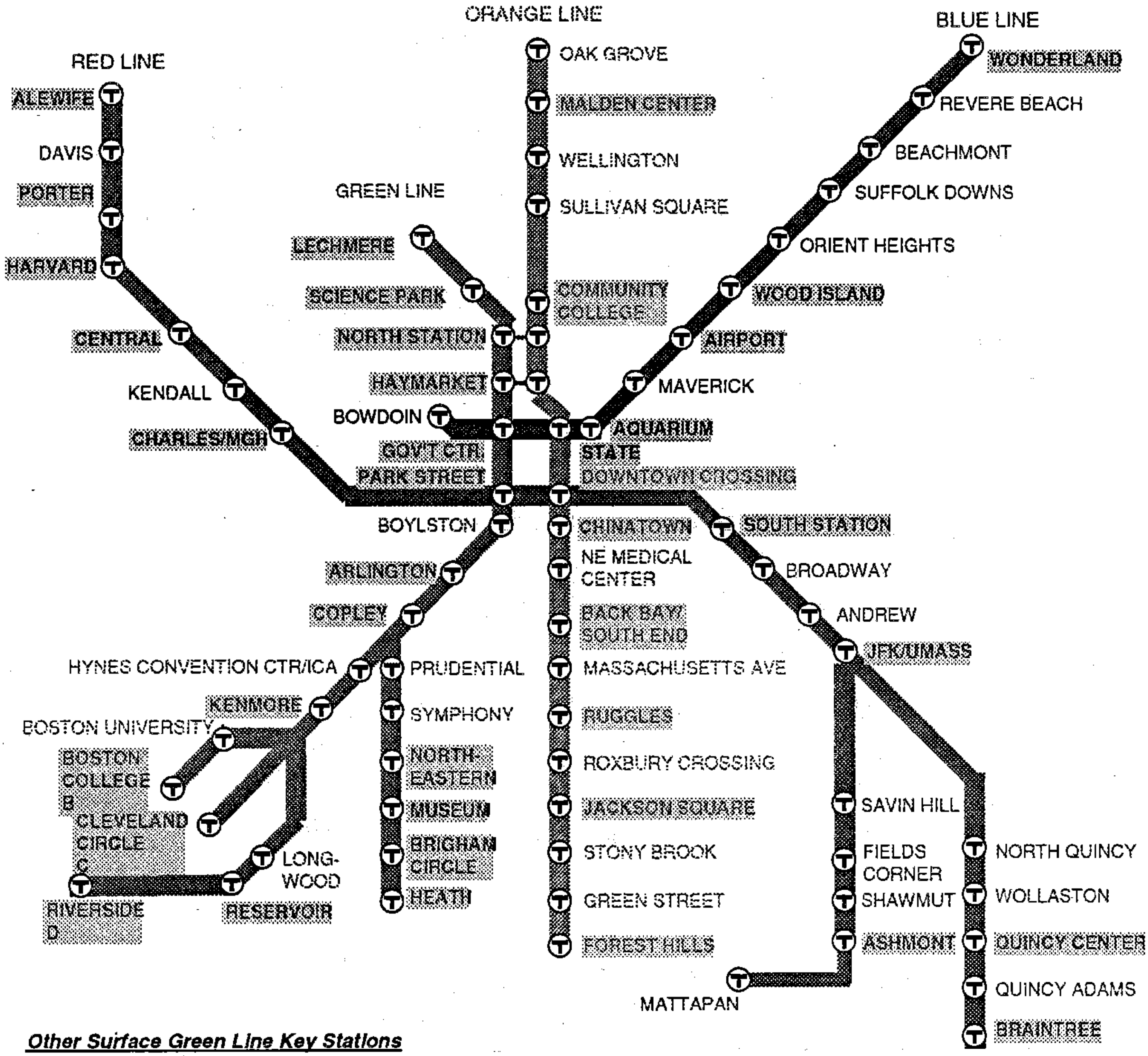
The passage of ADA in 1990 established requirements for transit systems to meet. All vehicles used on fixed routes must be accessible, and to the extent possible, all vehicles that are rebuilt must also be made accessible. ADA also requires that within five years, all subway and commuter rail trains with two or more cars have at least one car that is accessible. Finally, all new subway stations constructed after January 1992 must be accessible and "key" existing stations must be made accessible by July 1993. (See Chapter 2 for additional details on the requirements of ADA.)

The MBTA has submitted a "Key Station plan" to the Federal Transit Administration (FTA). This proposal calls for a total of 27 out of 52 rapid transit, 29 out of 78 light rail stations, and 22 out of 112 commuter rail stations to be designated as key stations (see Figures 7-1 and 7-2). The improvements necessary to bring the stations into compliance range from a simple retrofit to a major structural change. It is estimated that the cost to bring existing stations into compliance will be $244 million over a 20 year period. Because estimated completion dates for some stations are as far away as ten to eighteen years, the MBTA has applied for variances in meeting the July 1993 deadline for ADA accessibility. Schedules and costs on a station-by-station basis are shown in Table 7-1.

The Green Line light rail system is the most difficult line to make accessible because it operates in four distinct environments (underground, elevated, on the surface with its own right-of-way, and at grade with mixed traffic). Following a three year accessibility feasibility study, the MBTA has determined that the best approach is to operate low floor cars and raise platforms approximately eight inches. Even so, some surface stops may never be accessible because of environmental and architectural constraints. The cost of low floor Green Line vehicles will be approximately $320 million.

Although it may take 30 years to comply with the full accessibility requirements of the ADA, the bus fleet will become fully lift-equipped within a few years, and the rapid transit system, including the Green line, should be ADA compliant by 2011. At the same time, RIDE service will continue and expand in order to provide service for people with severe disabilities and for those people who do not live near rapid transit lines or other fixed route services.

Figure 7-1
Rapid Transit and Surface Green Line Key Stations

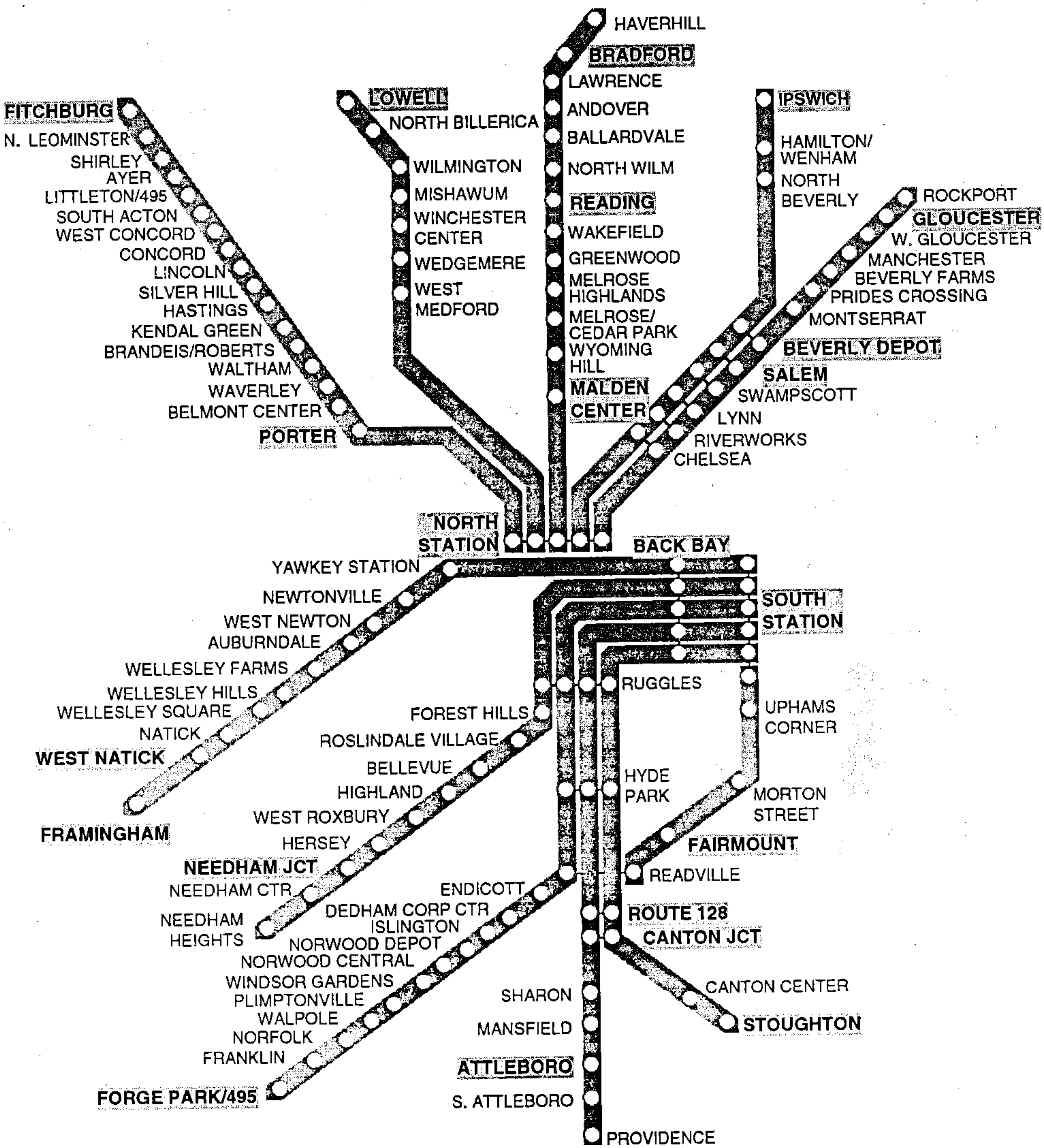


Other Surface Green Line Key Stations

B/Boston College Branch: *BU East, BU Central, Harvard Ave, and Washington St*
C/Cleveland Circle Branch: *St Mary's St, Coolidge Corner, and Washington Square*
D/Riverside Branch: *Fenway, Brookline Village, and Newton Centre*
E/Heath Street Branch: *Longwood Medical Area*

ALEWIFE = Key Station

Figure 7-2
Commuter Rail Key Stations



LOWELL = Key Station

Table 7-1
Key Station Plan

KEY STATIONS/STOPS	Ridership (Date+)	% of Avg Daily Boardings	Transfer: Rail Lines	Intermodal Transfer	End of Line	Close to Activity Centers		Cost ($Mil) 1992 $s	Project Time* in Yrs
Heavy Rail									
TRANSFER STATIONS									
@ PARK STREET	24,496	371%	Red/Green	Bus	No	Yes	Red	$0.6	2.0
							Green	$11.0	4.0
@ DOWNTOWN CRSN	25,325	383%	Red/Orange	Bus	No	Yes	Red	$0.6	2.0
							Orange	$5.0	4.0
GOVERNMENT CT	12,337	187%	Blue/Green	Bus	No	Yes	Blue	$19.0	4.0
							Green	$12.1	3.5
@ STATE	17,545	265%	Blue/Orange	Bus	No	Yes	Blue	$27.0	4.0
							Orange	$0.6	2.0
HAYMARKET	7,359	111%	Green/Orange	Exp. Bus	No	Yes	Orange	$5.6	3.0
							Green	$2.0	3.0
NORTH STATION	12,550	190%	Orange/Green	CRR	No	Yes	Orange	$7.0	3.0
							Green	$3.0	3.0
RED LINE									
@ ALEWIFE	8,010	121%	No	Rt 2/Bus/Pkg	Yes			$0.6	2.0
@ PORTER	5,692	86%	No	CRR	No	Hsg/Shopping		$0.6	2.0
@ HARVARD	18,592	281%	No	No	No	Harvard Univ		$0.8	2.0
@ CENTRAL	9,539	144%	No	No	No	CityHall/Shops		$0.6	2.0
CHARLES	7,283	110%	No	No	No	Hospitals		$10.0	4.0
@ SOUTH STATION	14,676	222%	No	CRR/EBus/AM	No	Fin.Dist/Shops		$0.6	2.0
@ JFK/UMASS	5,019	76%	Red A/Red B	No	No	UMass		$0.8	2.0
@ ASHMONT	7,607	115%	Green	Bus	Yes			$0.6	2.0
QUINCY CENTER	5,055	76%	No	Pkg	No	CityHall/Shops		$0.1	1.0
@ BRAINTREE	3,560	54%	No	Rt 3/Pkg	Yes			$0.6	2.0
ORANGE LINE									
@ FOREST HILLS	8,993	136%	Green	Bus / CRR	Yes			$0.6	2.0
@ JACKSON SQUARE	6,679	101%	No	Bus	No			$0.6	2.0
@ RUGGLES	4,310	65%	No	CRR/Bus	No	Museum/Schls		$0.6	2.0
@ BACK BAY	13,006	197%	No	Bus/CRR/AMT	No	Shopping/Hsg		$0.6	2.0
CHINATOWN	3,795	57%	No	No	No	Chinatown		$4.6	3.0
COMMUNITY COLL	2,752	42%	No	No	No	Tourism/Schl		$3.0	3.0
MALDEN	6,821	103%	No	CRR, Bus	(Near)			$3.0	3.0
BLUE LINE									
AQUARIUM	3,049	46%	No	Boat	No	Aq/Tourism		$6.5	5.0
AIRPORT	3,956	60%	No	Airport	No	Airport		$3.0	4.0
WOOD ISLAND	1,437	22%	No	Airport (Temp)	No			$3.0	3.0
WONDERLAND	4,689	71%	No	Bus	Yes			$0.6	2.0
Light Rail									
GREEN LINE									
LECHMERE	3,753	173%	Green E	Bus	Yes			$0.4	3.0
ARLINGTON	13,551	623%	GreenB/C/D/E	Exp Bus	No			$6.5	6.0
COPLEY	16,316	750%	GreenB/C/D/E	Bus	No			$5.0	4.0
KENMORE	7,878	362%	Green B/C/D	Bus	No			$10.0	6.0
SURFACE									
Mattapan Line									
Ashmont	3,229	148%	Red	Bus	Yes			$0.4	2.0
Mattapan	2,237	103%	No	Bus	Yes			$0.4	3.0

+ Ridership survey dates: Orange/Red/Blue Lines (Oct. 1989), Green Lines (Oct. 1989), Green Line (Oct. 1985), Commuter Rail (1992)
* Project time includes design and construction.
@ Wheelchair Accessible Station

7/15/92

Table 7-1 (Cont.)
Key Station Plan

Projected Capital Spending - in 1992 Dollars

KEY STATIONS/STOPS		FY '93	FY '94	FY '95	FY '96	FY '97	FY '98	FY '99	FY '00	FY '01	FY '02	FY '03	FY '04	FY '05	FY '06	FY '07	FY '08	FY '09	FY '10	FY '11
Heavy Rail																				
TRANSFER STATIONS																				
@ PARK STREET	Red		$0.1	$0.5																
	Green					$1.1	$4.4	$4.4	$1.1											
@ DOWNTOWN CRSN	Red	$0.1	$0.5																	
	Orange	$0.5	$2.0	$2.0	$0.5															
GOVERNMENT CT	Blue							$1.9	$7.6	$7.6	$1.9									
	Green				$1.2	$3.6	$8.1	$1.2												
@ STATE	Blue												$2.7	$10.8	$10.8	$2.7				
	Orange	$0.1	$0.5																	
HAYMARKET	Orange							$0.6	$3.9	$1.1										
	Green							$0.2	$1.4	$0.4										
NORTH STATION	Orange											$0.7	$4.9	$1.4						
	Green											$0.3	$2.1	$0.6						
RED LINE																				
@ ALEWIFE		$0.1	$0.5																	
@ PORTER		$0.1	$0.5																	
@ HARVARD								$0.1	$0.7											
@ CENTRAL								$0.1	$0.5											
CHARLES								$1.0	$4.0	$4.0	$1.0									
@ SOUTH STATION		$0.1	$0.5																	
@ JFK/UMASS											$0.1	$0.7								
@ ASHMONT				$0.1	$0.5															
QUINCY CENTER		$0.1																		
@ BRAINTREE		$0.1	$0.5																	
ORANGE LINE																				
@ FOREST HILLS		$0.1	$0.5																	
@ JACKSON SQUARE								$0.1	$0.5											
@ RUGGLES								$0.1	$0.5											
@ BACK BAY		$0.1	$0.5																	
CHINATOWN	(1993-95 PROJECT ALREADY FUNDED)																			
COMMUNITY COLL										$0.3	$2.1	$0.6								
MALDEN										$0.3	$2.1	$0.6								
BLUE LINE																				
AQUARIUM																$0.3	$1.0	$1.6	$2.6	$1.0
AIRPORT											$0.3	$1.2	$1.2	$0.3						
WOOD ISLAND	(1993-95 PROJECT ALREADY FUNDED)																			
WONDERLAND		$0.1	$0.5																	
Light Rail																				
GREEN LINE																				
LECHMERE		$0.05	$0.1	$0.3																
ARLINGTON		$0.05	$0.3	$1.0	$1.6	$2.6	$1.0													
COPLEY											$0.5	$2.0	$2.0	$0.5						
KENMORE		$0.05	$0.5	$1.5	$2.5	$4.0	$1.5													
SURFACE																				
Mattapan Line																				
Ashmont				$0.04	$0.38															
Mattapan				$0.05	$0.1	$0.3														

@ Wheelchair Accessible Station

7/15/92

Table 7-1 (Cont.)
Key Station Plan

KEY STATIONS/STOPS	Ridership (Date+)	% of Avg Daily Boardings	Transfer: Rail Lines	Intermodal Transfer	End of Line	Close to Activity Centers	Cost ($Mil) 1992 $s	Project Time* in Yrs
B Line								
BU East	2,390	110%	No	No	No	B.U.	$0.4	3.0
BU Central	2,376	109%	No	No	No	B.U.	$0.4	3.0
Harvard Avenue	3,115	143%	No	Bus	No	Shopping	$0.4	3.0
Washington St	1,372	63%	No	Bus	No	Housing	$0.4	3.0
Boston College	1,185	54%	No	No	Yes	B.C.	$0.4	3.0
C Line								
St. Mary's St	1,870	86%	No	No	No	M.A.B. #	$0.4	3.0
Coolidge Corner	3,232	149%	No	Bus	No	Shopping	$0.4	3.0
Washington Sq	947	44%	No	Bus	No	Shopping	$0.4	3.0
Cleveland Circle	1,490	68%	No	Bus	Yes	Shopping	$0.4	3.0
D Line								
Fenway	1,776	82%	No	No	No	Hosp/Park/Schls	$0.4	3.0
Brookline Village	2,924	134%	No	Bus	No	Shopping	$0.3	3.0
Reservoir	2,259	104%	No	Bus	No		$0.5	3.0
Newton Centre	1,256	58%	No	No	No	Carroll Ctr	$0.9	3.0
Riverside	1,582	72%	No	Exp Bus/Pkg	Yes		$0.4	3.0
E Line								
Northeastern	5,111	235%	No	No	No	NE Univ	$0.4	3.0
Museum Fine Arts	1,307	60%	No	No	No	MFA/Schools	$0.4	3.0
Longwood Medical	3,060	141%	No	No	No	Hospitals	$0.4	3.0
Brigham Circle	2,184	100%	No	Bus	No	Hospitals	$0.4	3.0
Heath St / VA Med.	558	26%	No	Bus	Yes	Hospitals	$0.4	3.0
Commuter Rail								
@ North Station			Orange/Green	No	Yes	Boston Garden	$1.3	1.0
@ South Station			Red	Bus/AMTRAK	Yes	Financial Dist.	$1.3	1.0
@ Back Bay			Orange	Bus/AMTRAK	No	Copley Place	$1.0	2.0
@ Salem	875	238%	No	Bus/Pkg	No		$0.2	2.0
@ Beverly Depot	787	214%	No	Bus	No		$0.2	2.0
@ Ipswich	233	63%	No	No	Yes		$0.4	2.0
@ Gloucester	339	93%	No	No	(Near)		$0.2	2.0
Bradford	265	72%	No	No	(Near)		$0.1	2.0
@ Reading	688	187%	No	Bus	No		$0.2	2.0
Malden	22	6%	Orange	Bus	No	Gov't Center	$1.0	3.0
@ Lowell	1,014	277%	No	Bus/Pkg	Yes	College	$0.2	2.0
Fitchburg	112	31%	No	Bus	Yes		$1.0	3.0
@ Porter Sq.	81	22%	Red	Bus	No	Hsg/Shopping	$0.2	2.0
Framingham	729	199%	No	No	Yes		$3.0	3.0
West Natick	543	148%	No	No	(Near)		$0.6	2.0
@ Needham Jct.	495	135%	No	Bus	(Near)		$0.2	2.0
@ Forge Park-495	710	194%	No	Rte 495	Yes	Route 495	$0.2	2.0
@ Attleboro	1,358	371%	No	No	(Near)	Downtown/Pkg	$0.2	2.0
@ Stoughton	1,214	332%	No	No	Yes		$0.2	2.0
Canton Jct.	1,097	298%	No	No	No		$1.0	2.0
Route 128	1,590	434%	No	Rt128/AMTRA	No	Route 128	$9.8	3.5
Fairmount	443	120%	No	No	No		$1.0	3.0

KEY STATION TOTALS: $179.5
KEY STATION TOTALS - Inflated: $243.7
(Assumed Inflation = 4%/Yr)

7/15/92

\+ Ridership survey dates: Orange/Red/Blue Lines (Oct. 1989), Green Lines (Oct. 1989), Green Line (Oct. 1985), Commuter Rail (1992)
* Project time includes design and construction.
\# Mass. Assoc for the Blind
@ Wheelchair Accessable Station

Table 7-1 (Cont.)
Key Station Plan

Projected Capital Spending - in 1992 Dollars

KEY STATIONS/STOPS	FY '93	FY '94	FY '95	FY '96	FY '97	FY '98	FY '99	FY '00	FY '01	FY '02	FY '03	FY '04	FY '05	FY '06	FY '07	FY '08	FY '09	FY '10	FY '11
B Line																			
BU East						$0.05	$0.1	$0.3											
BU Central	$0.05	$0.1	$0.3																
Harvard Avenue	$0.05	$0.1	$0.3																
Washington St	$0.05	$0.1	$0.3																
Boston College	$0.05	$0.1	$0.3																
C Line																			
St. Mary's St	$0.05	$0.1	$0.3																
Coolidge Corner	$0.05	$0.1	$0.3																
Washington Sq	$0.05	$0.1	$0.3																
Cleveland Circle	$0.05	$0.1	$0.3																
D Line																			
Fenway						$0.05	$0.1	$0.3											
Brookline Village	$0.05	$0.1	$0.2																
Reservoir	$0.05	$0.1	$0.4																
Newton Centre	$0.09	$0.2	$0.6																
Riverside	$0.05	$0.1	$0.3																
E Line																			
Northeastern	$0.05	$0.1	$0.3																
Museum Fine Arts						$0.05	$0.1	$0.3											
Longwood Medical	$0.05	$0.1	$0.3																
Brigham Circle						$0.05	$0.1	$0.3											
Heath St / VA Med.	$0.05	$0.1	$0.3																
Commuter Rail																			
@ North Station	$1.30																		
@ South Station	$1.30																		
@ Back Bay	(1993/94 PROJECT ALREADY FUNDED)																		
@ Salem			$0.02	$0.18															
@ Beverly Depot			$0.02	$0.18															
@ Ipswich			$0.04	$0.36															
@ Gloucester				$0.02	$0.18														
Bradford				$0.01	$0.10														
@ Reading			$0.02	$0.18															
Malden									$0.10	$0.70	$0.20								
@ Lowell				$0.02	$0.18														
Fitchburg				$0.10	$0.70	$0.20													
@ Porter Sq.				$0.02	$0.18														
Framingham			$0.30	$2.10	$0.60														
West Natick	(1993 PROJECT ALREADY FUNDED)																		
@ Needham Jct.				$0.02	$0.18														
@ Forge Park-495				$0.02	$0.18														
@ Attleboro				$0.02	$0.18														
@ Stoughton				$0.02	$0.18														
Canton Jct.		$0.10	$0.90																
Route 128						$1.00	$2.90	$4.90	$1.00										
Fairmount									$0.10	$0.70	$0.20								
KEY STATION TOTALS:	$5.0	$9.2	$11.6	$10.0	$14.3	$14.4	$13.0	$26.3	$14.9	$9.4	$6.5	$12.9	$13.6	$10.8	$3.0	$1.0	$1.8	$2.6	$1.0
KEY STATION TOTALS - Inflated:	$5.0	$9.6	$12.5	$11.3	$16.7	$17.5	$16.4	$34.6	$20.4	$13.4	$9.8	$19.9	$21.8	$18.0	$5.2	$1.8	$3.0	$5.1	$2.0

(Assumed Inflation = 4%/Yr)

7/15/92

@ Wheelchair Accessible Station

Total costs for ADA accessibility, including the items discussed above, are estimated at nearly $580 million for FY 1993 and beyond (see Table 7-2). Of this, $166 million is programmed for the period FY 1993 to FY 1997. The remainder is programmed for beyond FY 1997.

Table 7-2
Capital Costs for ADA-Related Improvements
($000s)

	Total Cost	FY 1993 - FY 1997	Beyond FY 1997
The RIDE			
RIDE Vehicles (60)	$1,817	$873	$0
Systemwide			
Key Station Plan	$242,930	$42,537	$200,391
Other	$5,563	$435	$0
Green Line			
Low Floor Vehicles	$319,500	$105,800	$213,700
Red Line			
Station Access (in addition to Key Station Plan)	$3,563	$3,563	$0
Orange Line			
Station Access (in addition to Key Station Plan)	$11,844	$9,733	$0
Commuter Rail			
Station Access	$2,787	$2,787	$0
Total	$588,004	$165,728	$414,091

Chapter 8
SIP and CA/T Mitigation Expansion Projects

This chapter describes the SIP and CA/T Mitigation Projects. These are as follows:

Short-Term

Old Colony Commuter Rail Restoration
Worcester Commuter Rail Extension
South Boston Piers Transitway
Washington Street Replacement Service
400 Buses
10,000 Additional Parking Spaces by 12/31/96
10,000 Additional Parking Spaces by 12/31/99
Newburyport Commuter Rail Extension
2 Commuter Boat Facilities

Long-Term

Green Line Extension to Medford Hillside
Blue Line - Red Line Connector
Green Line Arborway Restoration/Replacement

Nearly all of the SIP and CA/T service improvement projects have merit in terms of new ridership, VMT reduction, cost-effectiveness, and air quality benefits. With the possible exception of four projects, and assuming that sufficient funding is available, all are worthy of implementation with timeframes consistent with SIP and CA/T mitigation requirements. The exceptions are Green Line Arborway restoration, the Newburyport commuter rail extension, 400 buses, and two commuter boat facilities:

400 New Buses There has been considerable confusion with respect to the CA/T Mitigation requirement for the purchase of 400 buses. It appears that existing MBTA plans to purchase of 400 replacement buses were mistakenly translated into the purchase of 400 buses for expansion purposes. This appears to have been the result of confusing and contradictory language in the CA/T SFEIR (Part 1, Book 1, Page 350):

"The MBTA is purchasing 200 advanced design lift-equipped buses. These vehicles are replacing older buses in the existing bus fleet. The purchase of 200 additional units is planned by 1992. The new bus purchases will expand peak hour fleet capacity to accommodate up to 12,000 additional passengers by 1992, in each direction, assuming average one-way trips of 0.5 to 1 hour."

This reference acknowledges that the first 200 buses were replacement buses, and references already existing plans to purchase an additional 200 buses, which were also to be replacement buses. However, it then describes a capacity expansion that would not be provided by replacement buses.

The CA/T Mitigation requirement for the purchase of 400 buses is set forth in DEP's July 8, 1991 letter to Peter Zuk, "310 CMR 7.38 Conditional Acceptance of Preconstruction Certification of the Central Artery/Third Harbor Tunnel Project," (the "Vent Stack" letter):

"Purchase 400 new buses which shall placed [sic] in service by December 31, 1992 – to expand peak hour capacity to 12,000 additional passengers in each direction."

Due to similarity in language, it appears that this requirement was based on the SFEIR section cited above.

The requirement is also problematic in a number of other respects: (1) it is not practical, (2) it does not address services that would or could be provided, and (3) costs would be prohibitive:

(1) It is not practical in that it refers to increasing capacity, not ridership. New transit ridership is generated by introducing new services or improving existing services, not simply by increasing capacity. No specific services are mentioned in conjunction with the 400 buses. (The FSEIR mentions corridor bus studies that were underway which would be used as the basis for recommendations for bus route improvements. However, these studies are aimed at using existing resources more efficiently, and not at service expansion.)

(2) Without addressing the services that would or could be provided with the new buses, it is difficult to estimate potential new ridership. However, using characteristics of existing services, it is clear that the requirement is not realistic. Peak hour ridership ranges from around four percent of total weekday ridership on frequent, all-day, high-ridership routes (such as Route 1) to around 30 percent on peak-period-only express routes (such as Route 300). Therefore, a capacity increase of 12,000 peak hour trips per weekday per direction, if fully utilized, implies that the 400 buses would be utilized by 40,000 to 300,000 riders per weekday.

(3) The cost to purchase and operate 400 new buses would be very high. Capital costs would be $80 to 88 million. Then, if the buses were used only to provide weekday peak period service (seven hours per day), operating costs would increase by $66.7 million per year. If the buses were in service for longer periods (for example, from 6:00 am to 11:00 pm), and on weekends, operating costs would increase by $288.5 million per year. Given the current farebox return rate for bus services of approximately 22 percent, the operating deficit would increase by $52.0 to $225 million per year.

At the beginning of the PMT process, a number of efforts (as described in the Phase 1 and Phase 2 reports) were undertaken to identify the potential for new transit services. These efforts led to the development of the bus alternatives described in the PMT report and appendices. Of those that were examined, the recommended new services would require 47 new buses, be utilized by 19,980 riders per weekday, and increase total transit ridership by 9,250 trips per weekday. These increases, while significant, are below the increases included and implied in the requirement. Moreover, given the emphasis in the PMT process on identifying gaps in existing service coverage, and the results, it is unlikely that

any combination of new bus services could increase bus ridership by the 40,000 to 300,000 trips implied in the requirement.

Considering these problems, a substitute for the 400 buses appears warranted. A reasonable substitute that should be considered would be the bus service improvements that are recommended in the PMT: better downtown Boston bus distribution and three new express bus routes (as described in the "New/Improved Express Bus Services" and "Better Downtown Boston Bus Distribution" sections of Chapter 9). The capital costs of these two projects, at $6.1 million and $11.3 million respectively, would be significantly lower than the cost of 400 buses. This substitution would reduce capital costs associated SIP and CA/T Mitigation requirements by $70.8 million, while providing significant increases in bus ridership.

Newburyport Commuter Rail Extension A Newburyport extension would have a capital cost of $42.8 million, would carry 1,640 total riders (including 1,440 new transit trips), and reduce regional emissions by 0.04 percent. This project ranks fairly well compared to other PMT projects. However, similar ridership increases and air quality benefits could be achieved in the same corridor at a lower cost by improving service on the existing Rockport/Ipswich Line. As described in detail in Chapter 9, the institution of more frequent service, express trains, and higher maximum operating speeds, at a cost of $18.6 million, would attract 2,150 total riders (including 1,460 new transit trips), and also reduce regional emissions by 0.04 percent. This substitution could reduce capital costs associated SIP and CA/T Mitigation requirements by $24.2 million.

Green Line Arborway Restoration The PMT analysis indicates that while the restoration of Green Line service to Arborway would constitute a significant service improvement for existing riders, it would have a negligible impact on air quality. In this respect, it would be candidate for substitution as a SIP project, since many other projects in the recommended program could provide greater air quality benefits.

Whether or not the substitution of another project for Arborway restoration is made for SIP purposes, however, this project (or an alternative) should continue to be pursued. When service was suspended in 1985 due to Green Line construction and Huntington Avenue reconstruction, the MBTA made a commitment to restore service after construction had been completed. Subsequent passage of ADA now requires that restored service be accessible, which presents a number of complications for in-street operations. This, in turn, led to the consideration of trackless trolley replacement service in the PMT analysis, in addition to the evaluation of light rail restoration.

Total ridership would be high on either restored light rail, or a trolley bus replacement, service would be significantly more convenient for existing riders, and operating costs would be reduced by up to $2.6 million per year. Based on the potential passenger and operating cost benefits, and the MBTA's existing commitment to service restoration, Arborway Restoration/Replacement should continue to be considered as a high priority project. However, further study of alternative services using criteria specifically suited to the unique characteristics of the corridor also should be conducted.

Two Commuter Boat Facilities Massport and the CA/T project have recently initiated a study of ferry services; this study will be more comprehensive than the PMT analysis. It is recommended that a final decision on commuter boat facilities be made following the completion of this study.

Short-Term Projects (through 2000)

Old Colony Commuter Rail Restoration

Old Colony Commuter Rail Restoration involves the restoration of commuter rail service on three lines—Middleborough, Plymouth, and Greenbush—that were discontinued in 1959. Restoration of all three lines is a SIP commitment and required for CA/T mitigation. The FEIR for the Middleborough and Plymouth branches has been completed and these two lines are now under construction. Additional FEIR work on the Greenbush Line is now being conducted to determine noise and vibration impacts in Hingham Center. The figures presented herein are from the FEIR for the project.

The Old Colony Rail lines will serve 21 communities that presently do not have rail service (see Figure 8-1). There will be 21 stations on the three lines with a total of 8,000 parking spaces.

Projected ridership is 10,000 riders per weekday on the Middleborough Line, 5,800 on the Plymouth Line, and 7,400 on the Greenbush Line. In total, the three new lines will cost $40.1 million to operate and generate $19.0 million in new fare revenue. This would represent a farebox ratio of 47 percent. The capital cost for the restoration of all three lines will be approximately $560 million.

For more information on this project, refer to the "Old Colony Railroad Rehabilitation Project from Boston to Lakeville, Plymouth, and Scituate, Massachusetts," FEIR, March 1992.

Worcester Commuter Rail Extension

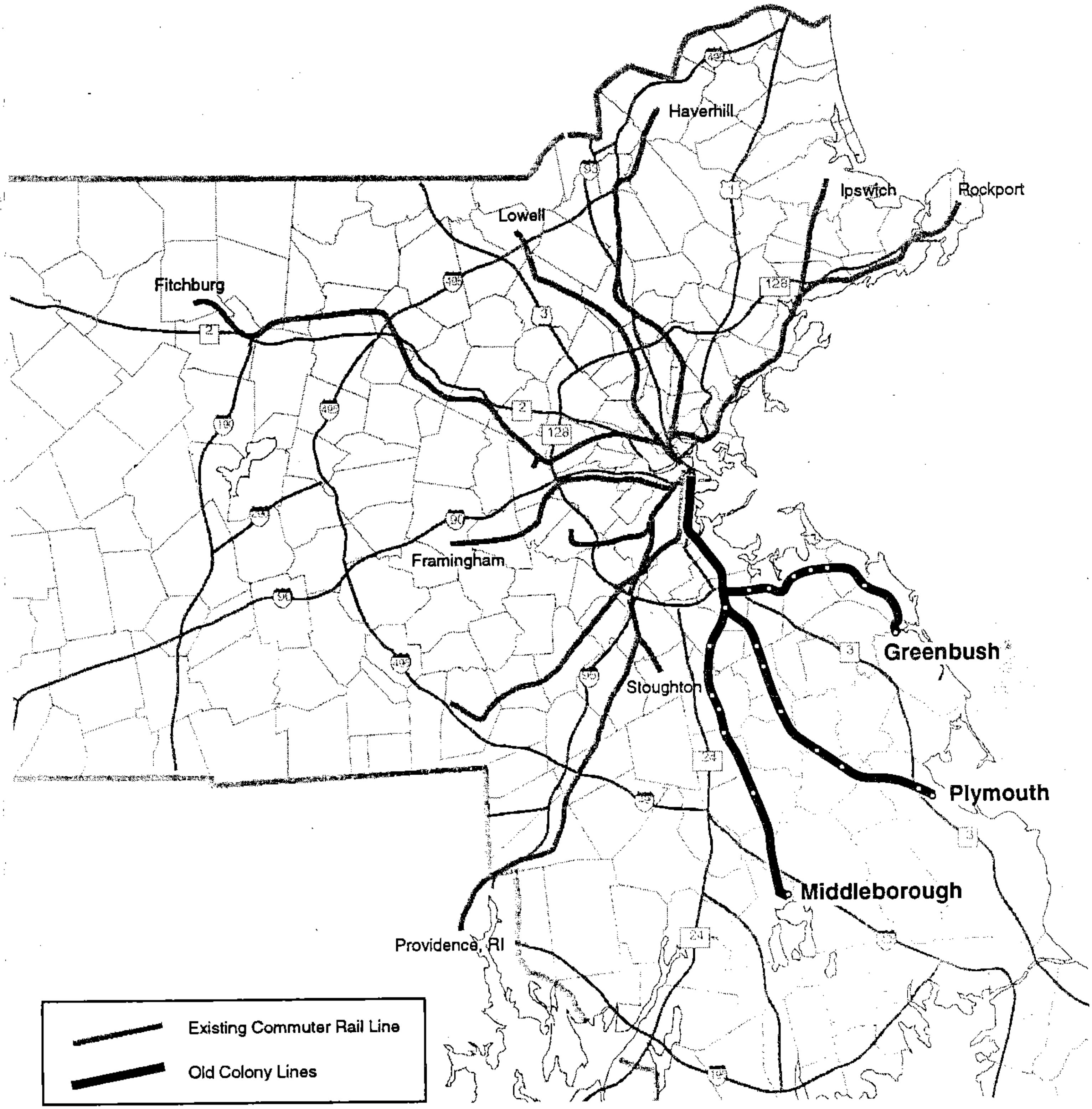
A commuter rail extension from Framingham to Worcester is a SIP commitment and required for CA/T mitigation. This project would consist of a 23 mile extension of the present Boston-Framingham commuter rail line (doubling its length) from the present terminal in Framingham through Ashland, Southborough, Westborough, Grafton, and Millbury to Worcester. Preliminary feasibility studies have been completed, and design and engineering work is underway.

There would be six stations on the extension:

Station	Parking	Fare Zone
Ashland	400	7
Southborough	400	7
Westborough	400	7
Grafton	400	8
Millbury	400	9
Worcester	500	10

The alignment for a Framingham-Worcester extension would be the Conrail Main Line. This is the primary route for railroad freight to and from Boston and points in southeastern Massachusetts. It also carries Amtrak intercity passenger trains.

Figure 8-1
Old Colony Rail Lines



During peak periods, a combination of express and local trains would be run. Express trains would stop at all stations on the extension and at Framingham, and then operate express to North Station. Local service would make all stops between Framingham and South Station (see Figure 8-2). During off-peak hours, all trains would run from Worcester and make all local stops.

A Worcester extension would serve a total of 6,700 trips per weekday, of which 3,470, or 52 percent would be new transit trips. This is the highest number of new trips that could be attracted by any commuter rail extension, and is a higher number of new trips than would be attracted by most other types of new services as well. The $119 million cost of the extension, in terms of the number of new trips that would be attracted, would be the second lowest among commuter rail extensions (behind Newburyport), and lower than for any Red, Blue, or Orange Line extension.

A Worcester extension would also reduce regional emissions by 0.10 percent, which is high. The only rail projects—commuter rail, rapid transit, or light rail—with similar air quality benefits are significantly more expensive. The capital cost, in terms of the air quality benefit (kg of VOC eliminated per weekday) is lower than most other rail projects. The Worcester extension would also recover 65 percent of its $7.2 million annual operating costs from fares. This is a high proportion, and better than the existing commuter rail system as a whole.

In more detail, the impacts of this project would be as follows:

Ridership Impacts

The Worcester extension combined with faster service and express trains would attract a total of 6,700 new trips per weekday, of which 3,470 would be trips diverted from automobiles. Most of these trips would be on the extension: 6,010 of the 6,700 total trips, and 3,200 of the 3,470 new transit trips (the remainder would be attracted by the faster service on the existing line and the fast express service from Framingham). Aside from the Fall River and New Bedford extensions, which would effectively be new lines, the Worcester extension would attract the highest number of total trips and diversions from automobiles of all of the commuter rail extensions examined. Ridership at individual stations would also be relatively high, although the highest ridership would be at the two innermost stations:

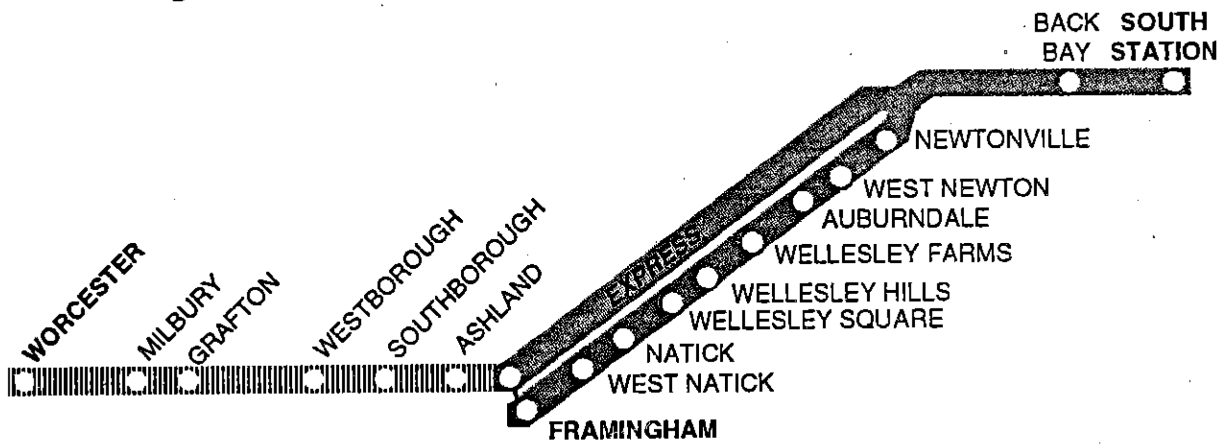
Worcester	1,040
Millbury	370
Grafton	340
Westborough	620
Southborough	1,770
Ashland	1,870
Total	6,010

To put these figures in perspective, of 97 outer stations in the existing system, only five now have higher ridership than projected for Southborough and Ashland. Worcester station would rank 17th.

Costs and Cost-Effectiveness

Along the Worcester extension alignment, Amtrak service is currently operated on the Framingham-Worcester segment, and the line is well maintained. However, substantial capital improvements would still be required in order operate faster service with a higher level of service. (The present maximum speed limit is 50 mph, and part of the line has been reduced to single track.) The total cost for station, track and right-of-way

Figure 8-2
Service Configuration with Worcester Extension



improvements,and for signaling and communications is estimated at $84.9 million. In addition, four new train sets would be needed at a cost of $34.0 million, bringing the total cost to $119.0 million.[1]

Worcester extension service would increase operating costs by $7.2 million per year, and would generate approximately 65 percent of these costs in fare revenue ($4.7 million). The capital cost per new rider would be $34,300, which would also be the second lowest cost among commuter rail extensions (after Newburyport).

Air Quality Impacts

The Worcester extension would reduce regional emissions by 0.10 percent. This figure is relatively high, and with one exception, other PMT projects with comparable air quality benefits are significantly more expensive. The capital cost per kilogram of VOC eliminated by weekday would be $1.5 million. This is a moderate cost for a rail extension.

South Boston Piers Transitway

The South Boston Piers Transitway involves the construction of a new transit line between South Station and the South Boston Piers area near the World Trade Center. The service would consist of electric dual mode buses operating in a tunnel with three stations: South Station, Fan Pier/Pier 4, and World Trade Center. Beyond the World Trade Center, transitway vehicles would operate on surface streets in the same manner as diesel buses. A DEIS for this project has been completed and FTA funding commitments have been received. The figures presented herein are derived from figures in the DEIS.

Projected ridership for the South Boston to World Trade Center portion of the transitway is 35,100 total trips per weekday, including 8,500 new transit trips. The capital cost is estimated at $355.9 million. Annual operating costs would be $16.3 million. The new transit trips would generate $15.1 million in new fare revenue, or 93 percent of operating costs.

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[1]Earlier estimates put the cost of a Worcester extension at approximately $80 million. The $119.0 million estimates includes higher station costs for high-level platforms and related changes for ADA compliance ($5.9 million) plus vehicle costs ($34.0 million).

For more information on this extension, refer to "South Boston Piers/Fort Point Channel: Transit Project," DEIS, June 1992.

Washington Street Replacement Service

Washington Street Replacement Service will consist of the implementation of trolley bus or light rail service on Washington Street between Dudley Square in Roxbury and Downtown Boston. The service is intended to replace that which was previously provided by the elevated Orange Line, which was relocated to the southwest corridor.

The MBTA had chosen trackless trolley as the preferred alternative, but recently, EOTC has decided to reexamine whether light rail might be preferable. There are several tradeoffs between the two possible modes: trackless trolley would be cheaper and faster to implement, would present fewer negative impacts on traffic congestion, would present less of a neighborhood barrier across Washington Street, and would provide more frequent service; light rail, on the other hand, is perceived to be a higher quality service, could potentially be faster, and may provide better integration into the current system. Service on the trackless trolley could be made nearly equivalent to the light rail option in terms of integration by operating it into Boylston Station and connecting it to the South Boston Piers Transitway.

A final decision on which mode to build will be made after extensive consultation with local residents, interest groups, and the City of Boston. Consultation with the community is ongoing, but may conclude within the next two to three months.

This project will be funded solely with state funds, and as a result, only the state environmental process is required. The MBTA had prepared an Environmental Notification Form (ENF) for trackless trolley service that was submitted to EOEA in 1990. According to the MBTA, the implementation of trackless trolley service in the near future would likely require the submittal of a "Notice of Project Change" to respond to issues raised following the submittal of the 1990 ENF and to update figures contained therein. The implementation of light rail service would likely require the preparation of an EIR, which would take 18-24 months.

A summary of the characteristics and impacts of the two modes is presented below. The figures presented herein are derived from the ENF for a trolley bus service (with the reconsideration of light rail, these figures may change).

Trackless Trolley

During peak periods, trackless trolley service would operate at four minute headways. The travel time between Dudley Square and Downtown Crossing (the interim terminus for the trackless trolley option) would be approximately 20 minutes. Free transfers would be provided to the Orange Line, Green Line, and Red Line.

Projected ridership for the initial trackless trolley alternative is 10,200 total trips per weekday. The capital cost is estimated at $40.0 million. Annual operating costs would be approximately $350,000 less than for the replacement bus services that are now being provided. Fare revenue would be essentially the same.

Light Rail

As presented in the 1990 ENF, the light rail alternative would operate at 12 minute headways. Travel time from Dudley Square to the Boylston Green Line station would be

approximately 13 minutes, although service would continue in the subway to Government Center. Free transfers within the subway would be available to all four existing subway lines.

Projected ridership on the light rail line would be 11,800 trips per weekday. The estimated capital cost would be up to $88 million depending on the alignment used at the downtown end. Annual operating costs would be approximately $950,000 less than current bus services, while fare revenue would remain about the same.

For more information on this extension, refer to MBTA's ENF, which was submitted to the Executive Office of Environmental Affairs in August 1990.

400 New Buses

The purchase of 400 new buses was included as a CA/T Mitigation project that was intended to increase ridership by 12,000 trips per weekday. Although the requirement did not specify the types of services that were to be provided with these buses, it is presumed that they could consist of a combination of new services and the expansion of existing services (in terms of more frequent service, more route variations, etc.). The cost of purchasing 400 buses would be high, at approximately $88 million.

An increase in ridership of 12,000 bus trips per day could be achieved with fewer buses and at a lower cost by improving downtown Boston bus circulation and by implementing new express bus routes. Better downtown Boston bus circulation (as described in Chapter 9) would increase total bus ridership by 11,800 trips per day, including 7,220 new transit trips at a capital cost of $6.1 million. The institution of three new express bus routes with park and ride lots (also as described in Chapter 9) would increase ridership by 8,090 bus trips per weekday, including 6,350 new transit trips, at a cost of $11.0 million.

As discussed in the beginning of this chapter, the PMT makes no specific recommendation with respect to the purchase of 400 buses, but does recommend that the two bus service expansion projects—better downtown Boston bus distribution and new express bus routes (subject to available funding)—be considered as substitutes.

The purchase of 400 new buses is a CA/T Mitigation project intended to "expand peak hour capacity to 12,000 passengers in each direction." As discussed earlier in this chapter, this requirement lacks clarity and does not specify the types of services that were to be provided with these buses. Of all of the bus services examined in the PMT, those that would provide significant ridership increases in a cost-effective manner would require a total of 47 new buses. These services would be utilized by 19,980 riders per weekday, and increase total transit ridership by 9,250 trips per weekday.

Further, the cost to purchase and operate 400 new buses would be very high. Capital costs would be $80 to $88 million. Then, if the buses were used only to provide weekday peak period service (seven hours per day), operating costs would increase by $66.7 million per year. If the buses were in service for longer periods (for example, from 6:00 am to 11:00 pm), and on weekends, operating costs would increase by $288.5 million per year. Using the current farebox return rate for bus services of approximately 22 percent, the operating deficit would increase by $52 to $225 million per year.

Given the high costs, and that new services that would fully utilize 400 buses could not be identified, the substitution of the bus service improvements recommended in the PMT should

be considered. These include better downtown Boston bus distribution and three new express bus routes (as described in the "New/Improved Express Bus Services" and "Better Downtown Boston Bus Distribution" sections of Chapter 9). The capital costs of these two projects, at $6.1 million and $11.3 million respectively, would be significantly lower than for 400 buses, while providing significant increases in bus ridership.

10,000 Parking Spaces by 12/31/96, and 10,000 Parking Spaces by 12/31/99

Until the recession, access to much of the rapid transit and commuter rail systems was constrained by the lack of available parking. Even with demand down from peak 1989 levels, a large number of stations remain at or beyond capacity. Projected growth will increase demand.

Both the SIP and CA/T Mitigation conditions require the expansion of park and ride facilities: 10,000 new spaces by the end of 1996 and 10,000 spaces by the end of 1999. The addition of new spaces will increase ridership in the short-term by adding supply for existing unmet demand and in the long-term by providing supply for new demand.

There is a large degree of flexibility in determining which new lots could be constructed and/or expanded to meet the SIP and CA/T requirements. Much of the 1996 commitment will be met through the construction of the Old Colony Line stations; the remainder of the commitments could be met through the new facilities on new services, new lots on existing lines, or the expansion of existing lots. The PMT analysis did not go as far as determining which specific park and ride expansion projects should be constructed to meet the commitments; this will require more detailed analysis than was possible within the scope of the PMT. The costs that are presented for the various categories (by 1996, by 1999, and as additional expansion) are estimates developed by proportioning the total cost for all potential new expansion by the number of spaces in each category. This means that it will be possible to shift costs between years and categories as the project becomes better defined.

This section addresses the expansion of existing park and ride lots, and the construction of new stations with parking on existing lines ("Intercept Stations"). (The provision of parking in conjunction with rapid transit and commuter rail extensions was examined within the context of the individual expansion projects.) As described further below, the expansion of existing lots and the construction of new stations with parking would be one of the most effective ways to increase transit ridership, improve air quality, and reduce the operating deficit.

The types of parking expansion projects that would be effective, including the specific parking expansion projects that were examined, are:

(1) New intercept stations, which would consist of new stations with parking located at the intersection of existing express services and major highways.

(2) The expansion of existing MBTA lots.

(3) The construction of new lots along existing express bus routes.

Intercept Stations

Beyond the core area, the predominant mode of access to express type services is by automobile. Existing stations at the intersection of major highways and rail lines are

among the most heavily utilized. Current stations with convenient access from major highways are the following:

Station	Line	Highway
Alewife	Red Line	Route 2
Riverside	Green Line	Route 128
Quincy Adams	Red Line	Routes 128, I-93, and 3
Braintree	Red Line	Route 3
Dedham Corporate Center	Franklin CR	Route 128
Route 128	Attleboro/Stoughton CR	Route 128
Forge Park/495	Franklin CR	I-495
Mishawum	Lowell CR	Route 128

Most lines do not have stations located adjacent to major highways that also have convenient access and sufficient parking. In some cases, this causes riders to park on local streets instead, generating friction with local residents and business. Potential locations for new stations that would improve both access and community relations are as shown in Table 8-1 and Figure 8-3.

Table 8-1
Potential Intercept Stations along Major Highways

Station	Line	Highway	Parking Spaces
Lawrence/495	Haverhill/Reading CR	I-495	1,000
Lowell/495	Lowell CR	I-495	500
Littleton/495	Fitchburg CR	I-495	300
Gillette/I-93	Haverhill/Reading CR	I-93	100
Community College	Orange Line	I-93	1,900
Industriplex	Lowell CR	I-93/Route 128	1,000
Wakefield/128	Haverhill/Reading CR	Route 128	300
Route 128/Mass Pike	Framingham CR, Express	Route 128	1,000
Needham/128	Needham CR	Route 128	800
Newton Corner	Express Bus (301, 302, 304)	Mass Pike	900

Expansion of Existing Lots

The MBTA has identified the existing lots that it believes could be expanded by the end of 1996, the end of 1999, and thereafter. As detailed in Appendix G, 1,510 spaces could be added at existing lots by 1996, 10,967 by 1999, and an additional 8,678 thereafter.

New Lots on Existing Express Bus Routes

Most existing express bus routes do not have parking facilities although they serve the same type of market and rapid transit and commuter rail services. As a result, their markets are limited and ridership is lower than it otherwise would be. Potential location for park and ride lots along existing express bus routes would be as shown in Table 8-2 and Figure 8-4.

Overall, the expansion of existing park and ride facilities, and the construction of new lots would be one of the most cost-effective ways to divert a significant number of automobile users to transit for the majority of their trip—up to 17,660 trips per weekday. The cost of parking expansion would be low relative to the number of new trips attracted, at $1,600 to

Figure 8-3
Intercept Parking Locations

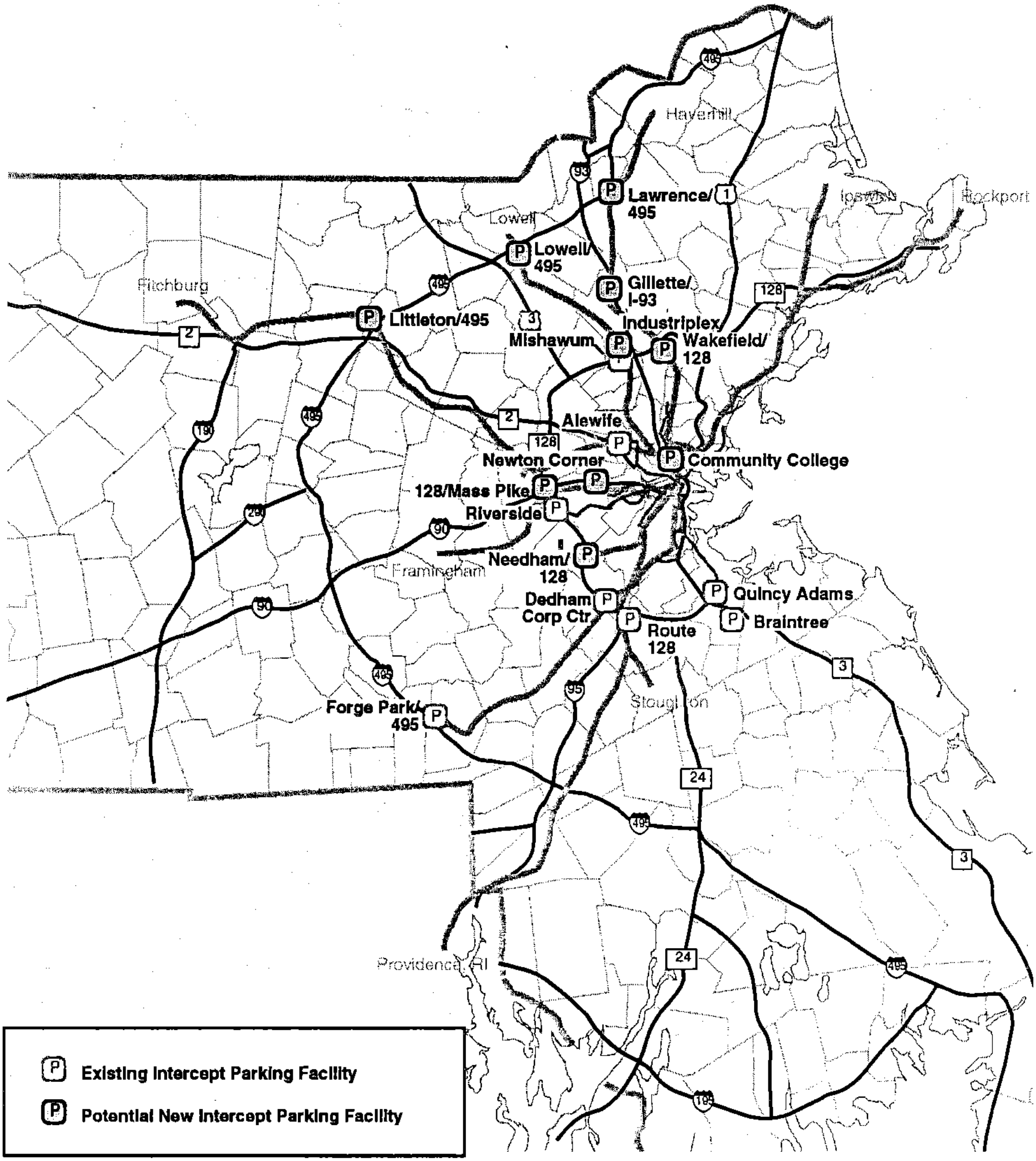

Figure 8-4
New Park and Ride Lots on Existing Express Bus Routes

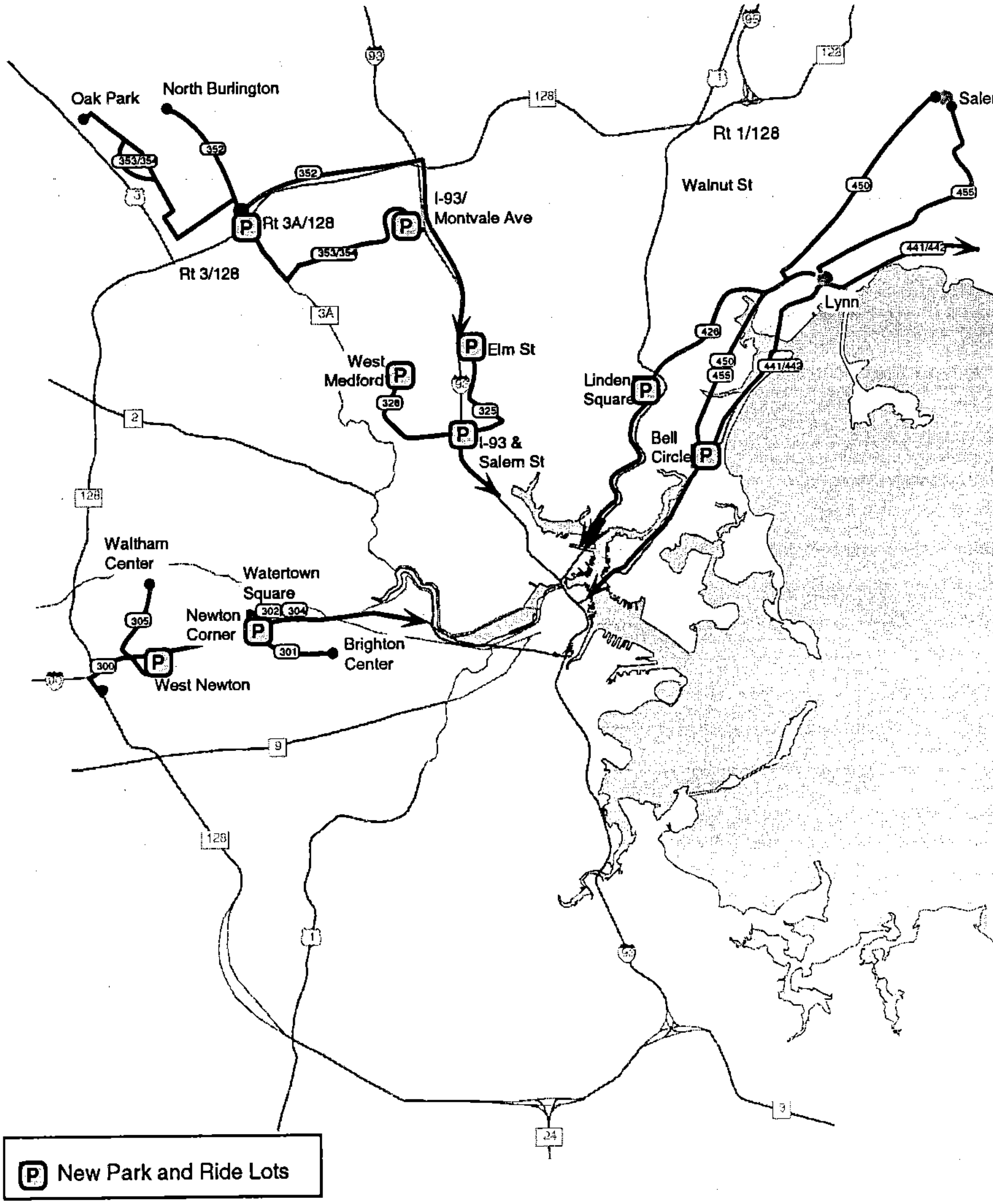

Table 8-2
Potential Park and Ride Lots Along Existing Express Bus Routes

	Size	Routes Served
North Shore		
Bell Circle, Revere	100	441, 442, 450, 455
Route 60 at Route 1, Revere	50	426
Burlington and I-93 Routes		
Routes 3A and 128, Burlington	350	352
Playstead Road at Winthrop Street, Medford	150	326
Fellsway West at Elm Street, Medford	100	325
Salem Street at I-93, Medford	400	325, 326
Mass Pike Routes[2]		
Route 16 at Mass Pike, West Newton	150	305

$34,900 per new transit trip, excluding land costs. Even with allowances for high land costs, the capital cost per new trip would be very low for most locations. Finally, the expansion of parking facilities would generate up to $11.1 million per year in new fare and parking fee revenue. Considering that the cost of "operating" park and ride facilities is low, most of this new revenue would represent a reduction in the annual operating deficit.

In more detail, the ridership, cost, and air quality impacts would be as follows:

Ridership Impacts

If all of the new intercept stations considered above were constructed, they would be used by 6,090 cars per weekday. Assuming an average auto occupancy of 1.17 and two one-way trips per person per weekday, this would translate into a total demand at these stations of 14,310 trips per weekday. Of these, approximately 28 percent, or 3,980, would represent new transit trips. The remainder would generally represent trips made by existing commuter rail riders who would find the new stations more convenient. The new ridership would represent one of the largest diversions from automobiles to transit of all PMT projects. (Additional detail on individual stations can be found in Appendix G.)

There will also be a large demand for the expansion of existing park and ride facilities. On a line-by-line basis, there will be more new demand at these facilities on most lines by 2020, even with the construction of all possible expansions (see Table 8-3). On rapid transit, exceptions would be the Red Line, where supply would be nearly balanced, and the Blue Line, where fewer spaces would be needed. On commuter rail, demand would exceed supply on all lines except the Attleboro/Stoughton Line (where the largest increases are possible).

(Note that the analysis conducted herein was, as mentioned above, conducted on a line-by-line basis, and not a station-by-station basis. These figures indicate that there will be a large demand for additional park and ride facilities, especially if rapid transit and commuter rail services are improved and expanded. However, additional analysis is still required to determine if the potential expansions assumed herein are the most appropriate to serve the projected demand.)

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[2]Note that a Newton Corner parking garage, which would serve existing express bus routes, was examined as an "intercept station."

Table 8-3
2020 Parking Demand at Existing Rapid Transit and Commuter Rail Lots

	1988 Spaces	2020 Demand
Rapid Transit		
Red Line	8,679	11,520
Orange Line	2,598	5,850
Blue Line	2,092	2,700
Green Line	2,223	4,500
Subtotal-Rapid Transit	15,592	24,570
Commuter Rail		
Rockport/Ipswich	1,372	4,100
Haverhill/Reading	985	3,510
Lowell	1,374	4,050
Fitchburg	800	2,970
Framingham	860	3,060
Needham	611	1,980
Franklin	1,155	4,250
Attleboro/Stoughton	2,359	5,220
Subtotal-Commuter Rail	9,516	29,140
Total	25,108	53,710

The total 2020 parking demand for park and ride expansion represents an increase in ridership of 14,490 new rapid transit trips and 19,100 new commuter rail trips. Of these, 3,690 of the rapid transit trips, and 8,350 of the commuter rail trips would represent new transit trips.

New park and ride facilities along existing express bus routes would attract 2,410 total trips and 1,640 new transit trips. The lots with the highest demand would be Route 128 at Route 3A in Burlington (which would be served by MBTA Route 352), and at I-93 at Salem Street in Medford, which would be served by MBTA Routes 325 and 326 (see Table 8-4).

Table 8-4
Demand for Parking Facilities along Existing Express Bus Routes

Location	Routes	Parking Demand	Weekday Transit Trips
Bell Circle, Revere	441, 442, 450, 455	40	100
Route 60 at Route 1, Revere	426	40	100
Routes 3A and 128, Burlington	352	310	740
Playstead Road at Winthrop Street, Medford	326	130	300
Fellsway West at Elm Street, Medford	325	50	120
Salem Street at I-93, Medford	325,326	350	820
Route 16 at Mass Pike, West Newton	305	100	230
Total		1,020	2,410

Note: Parking demand is in terms of the number of cars per weekday.

Costs and Cost-Effectiveness

The construction of intercept stations with parking on existing lines would be inexpensive compared to the implementation of new rail services. If all of the potential new stations were constructed, the total cost, excluding land acquisition, would be $60.2 million. These costs, in terms of the new transit ridership generated would be low. Exclusive of land acquisition costs, the capital cost per new transit rider would be only $15,100. If land acquisition doubled the cost to over $30,000, this would still be among the lowest costs per new transit rider among all PMT projects.

The expansion of parking facilities at existing stations would also be inexpensive compared to the implementation of new rail services. If all of the potential new spaces were constructed, total costs, excluding land acquisition would be $128.9 million for rapid transit and $89.6 million for commuter rail. Costs for parking expansion at individual stations would range from a low of $50,000 to up $50 million (for a major expansion of the Route 128 station; capital costs for individual stations are included in Appendix G). In terms of the new transit ridership generated, these costs would be relatively low for rapid transit and very low for commuter rail. Exclusive of land acquisition costs, the capital cost per new transit rider would be $34,900 for rapid transit and $10,700 for commuter rail (rapid transit is higher because more of the expansions involve parking garages instead of surface lots). Even with land acquisition, these costs should remain relatively low.

Assuming that new lots on existing express bus routes would be surface lots, and exclusive of land acquisition, capital costs per lot would range from $100,000 to $800,000 (see Appendix G). The total for all lots be approximately $2.6 million. The capital cost per new transit rider would be very low at $1,600.

Operating costs for all new lots would be low relative to the new fare revenue and parking revenues that would be generated. As a result, park and ride expansion is one of only a few expansion programs that would reduce the operating deficit. For the intercept stations up to $2.8 million would be generated in new fare and parking revenue ($2.2 million from fares; $0.6 million from parking fees).[3] For the expansion of existing rapid transit and commuter rail park and ride lots, up to $7.8 million would be generated in new fare and parking revenue ($3.3 million from fares; $4.5 million from parking fees). For new lots on express bus routes, $0.5 million in new fare revenue would be generated (these lots were assumed to be free, so no parking revenue would be generated). In total, all of the rail park and ride expansion projects could generate up to $11.1 million per year in new operating revenue.

Air Quality Impacts

Construction of all of the new intercept lots would reduce regional emissions by up to 0.08 percent. This would place intercept park and ride lots as among the more effective projects in the PMT in terms of air quality benefits. The cost of achieving these benefits, in terms of the cost per kilogram of VOC eliminated per weekday, would be low, at $867,500 (plus land acquisition costs).

The expansion of existing lots would reduce regional emissions by up to 0.18 percent (0.04 percent for rapid transit and 0.14 percent for commuter rail). This would place park and ride expansion as among the more effective projects in the PMT in terms of air quality benefits (second only to the North Station - South Station Rail Link). The cost of achieving

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[3]Parking fees were assumed to be $2.50 per day at rapid transit stations, $1.00 at commuter rail stations, and free at bus lots.

these benefits, in terms of the cost per kilogram of VOC eliminated per weekday, would be moderate for rapid transit, at $4,212,000, and very low for commuter rail at $745,000

The provision of park and ride facilities along existing bus routes would reduce regional emissions by 0.03 percent. This would be relatively low, but the cost of achieving these reductions would be very low, at $98,700 per kilogram of VOC eliminated per weekday.

Newburyport Commuter Rail Extension

A commuter rail extension from Ipswich to Newburyport is a SIP commitment and required as CA/T mitigation. As discussed in the beginning of this chapter, the institution of more frequent service, express trains, and higher maximum operating speeds, at a cost of $18.6 million, would attract essentially the same number of new transit trips and provide the same air quality benefits.[4] This potential substitution could reduce capital costs associated SIP and CA/T Mitigation requirements by $24.2 million.

The Newburyport extension would involve a 9.6 mile extension of service from Ipswich to Newburyport, and a number of running time and express service improvements. The alignment would be the former Boston & Maine Railroad Eastern Route Main Line, along which service is currently abandoned. There would be two stations on the extension: one in Rowley and the new terminal in Newburyport. Rowley would be in Zone 7 and Newburyport would be in Zone 8. Parking would be provided at both stations.

During peak periods, Rockport branch express trains would make all stops from Rockport to Salem (see Figure 8-5), and then run express to North Station. Ipswich branch trains would stop at all stations, including those on the shared portion of the line from Swampscott south.

Peak period service on both branches would be operated at 30 minute headways. During off-peak periods, all trains would stop at all stations with service levels similar to current off-peak service. The travel time from Newburyport would be 62 minutes, and the travel time from Rowley would be 55 minutes.

The Newburyport extension would have the second highest ridership of all of the commuter rail extensions examined and would perform reasonably well in terms of ridership, operating costs, fare revenue, and air quality benefits. The extension would attract 1,640 total rider and 1,440 new transit trips. Combined with service improvements on the existing line, total new ridership would be 3,790 trips per day and 2,900 new transit trips.

The extension would cost $1.7 million per year to operate and generate $1.3 million in new fare revenue. This would represent a farebox ratio of 76 percent. The new transit trips attracted by the extension would reduce regional emissions by 0.04 percent. The capital cost for the extension ($42.8 million), relative to the number of new passengers that would be attracted, and the air quality benefits that would result, is low to moderate relative to other rail extension projects.

In more detail, the impacts of this extension would be as follows:

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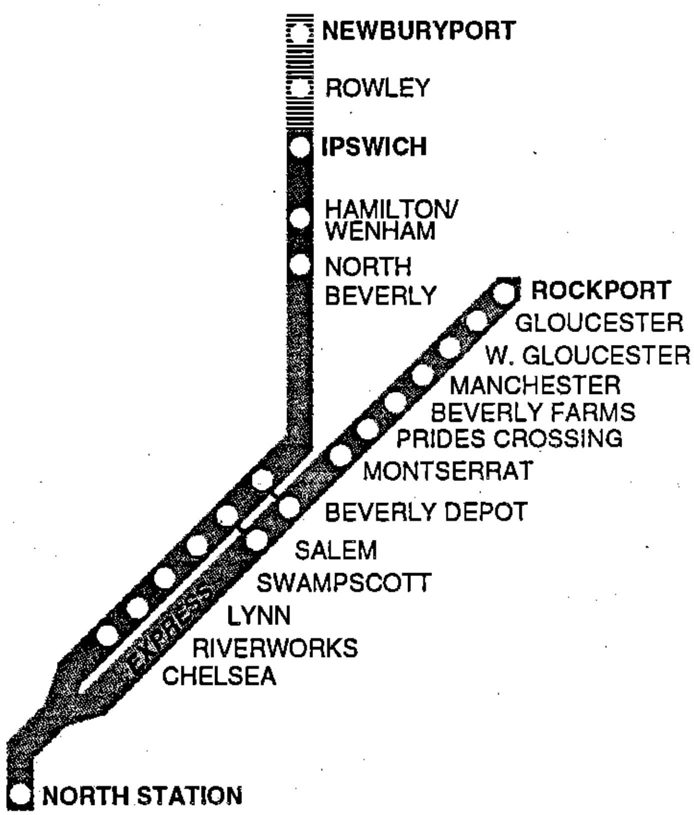
[4]The improved service that could be provided on the Rockport/Ipswich Line that would provide similar benefits to the Newburyport extension is described in detail in the "Commuter Rail Express Service" section of Chapter 9.

Figure 8-5
Extension to Newburyport w/Rockport Express Trains



Ridership Impacts

Ridership by station on the extension would be:

Newburyport:	1,040
Rowley:	600
Total	1,640

As a matter of comparison, ridership at Newburyport would be higher than current ridership at existing Ipswich branch stations (250 to 600 trips per weekday). Rowley ridership would be similar to that at Ipswich and Hamilton/Wenham, and higher than at North Beverly.

Costs and Cost-Effectiveness

The extension from Ipswich to Newburyport would cost approximately $25.7 million for track, signals, the two stations, and a layover facility (the right-of-way is already owned by the MBTA). In addition, two new train sets would be required to operate service along the extension, at a cost of $17.1 million. This would increase the total cost to $42.8 million. The capital cost per new transit rider would be $29,800, which would be moderate for a rail extension.

Air Quality Impacts

The Newburyport extension would reduce regional emissions by 0.04 percent. The capital cost per kilogram of VOC eliminated per day would be $1.6 million for the extension. This cost falls within the middle of the range of the same costs for other PMT projects.

Two Commuter Boat Facilities

Five different ferry services that could utilize new commuter boat facilities were examined as part of the PMT Update. These were:

- North Station to Fan Pier and World Trade Center
- North Station to Navy Yard Pier 4 and Logan Airport
- South Station to Long Wharf and Navy Yard Pier 4
- Navy Yard Pier 4 to Long Wharf and World Trade Center
- South Station to Navy Yard Pier 11

The PMT analysis indicated that, without supporting transit services to feed the docking terminals, nearly all of the ridership on each route would consist of existing transit riders that would shift from rapid transit and buses to the ferries. As a result, the air quality and downtown traffic benefits would be very small.[5]

Massport and the CA/T project have recently initiated a study of ferry services that will be more comprehensive than the PMT analysis. If that study is successful in determining a more effective manner of operating new ferry services, the new commuter boat facilities may be warranted. If not, a substitution should be considered. Better downtown bus circulation and/or improvements to commuter rail service (on the Rockport/Ipswich, Haverhill/Reading, Lowell and Franklin Lines) would be potential alternate projects that would remove traffic from downtown Boston streets.

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[5]For additional information on the PMT analysis of these services, see Appendix G.

Long-Term (after 2000)

Green Line Extension to Medford Hillside (near Tufts)

A Green Line extension to Medford Hillside would provide rapid transit service through Somerville to Medford Hillside in the vicinity of Tufts University. The extension would run from Lechmere Station 3.9 miles along railroad rights-of-way to Medford Hillside. There would be stations at Washington, School, and Lowell Streets in Somerville, at Ball Square (Broadway) on the Somerville/Medford border and at Medford Hillside (see Figure 8-6). The School Street and Lowell Street Stations would each include 50 parking spaces. The Medford Hillside Station would have 200 spaces.

A Green Line extension from Lechmere to Medford Hillside would serve an estimated 11,560 riders a day; of these, 3,660 would be new transit users. This extension would be among the better projects examined for the PMT in terms of capital cost per new weekday transit rider ($24,000), annual cost per hour of travel time saved ($11.02), and capital cost per weekday kilogram of VOC eliminated ($1.9 million). The extension would provide a moderate reduction in regional emissions of 0.06 percent.

The capital cost of the extension would be approximately $88.0 million. It would cost $2.1 million per year to operate and generate $1.1 million in new fare revenue. This would represent a farebox return of 52 percent, which is significantly higher than the 34 percent generated by the existing Green Line.

Note that the PMT also examined a Blue Line extension from Bowdoin to Medford Hillside along the same alignment between Lechmere and Medford Hillside, which would also include the Red Line - Blue Line Connector. A Green Line extension to Medford Hillside and a Red Line - Blue Line Connector together would attract more new transit users than a Blue Line extension to Medford Hillside at a much lower cost.

In more detail, the impacts of this project would be as follows:

Ridership

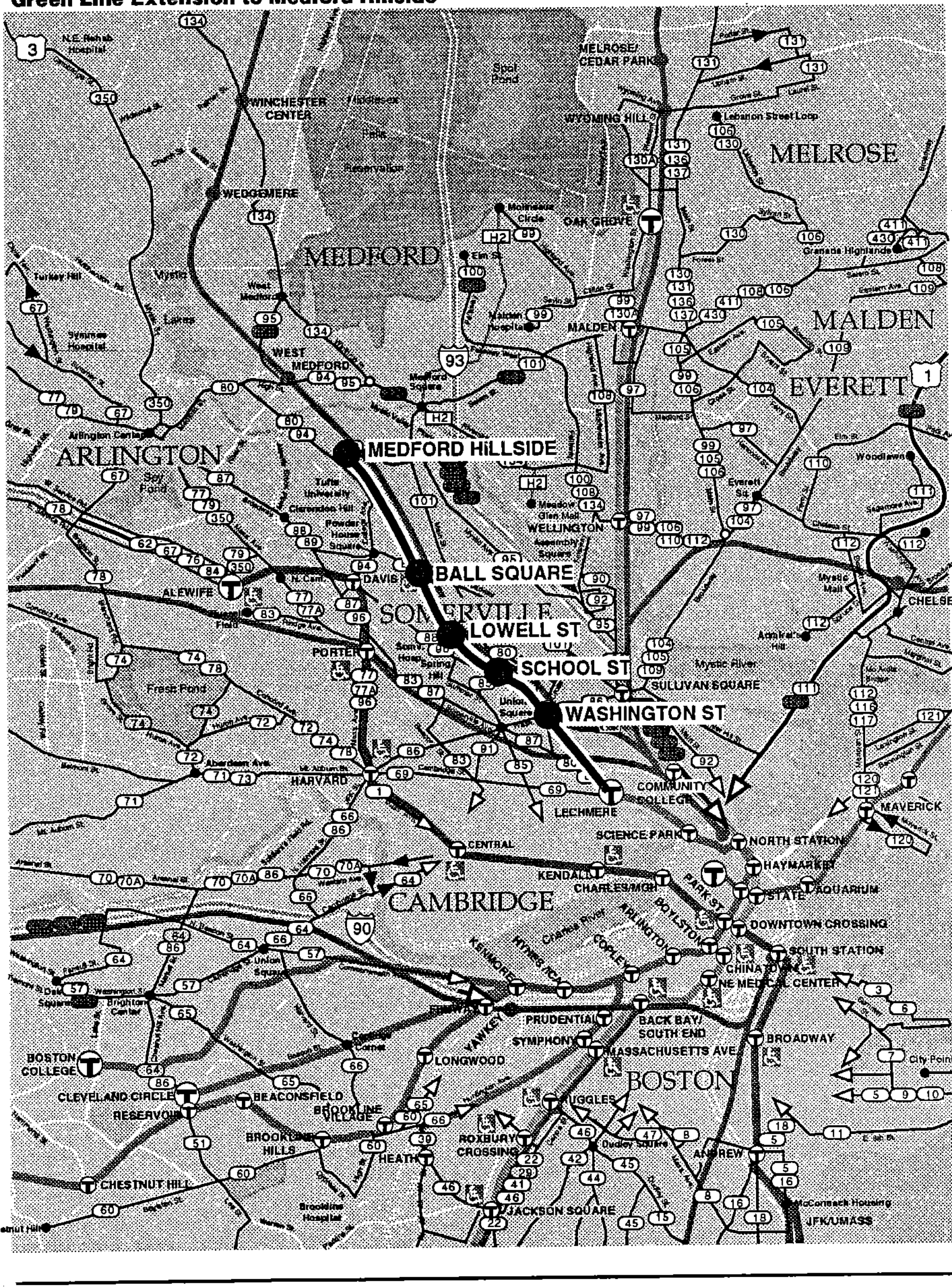
A Green Line extension from Lechmere to Medford Hillside would serve an estimated 11,560 riders a day. Of these, 3,660 would be new transit users, and 7,990 would be diverted from other MBTA services—primarily Somerville bus routes.

Costs

The estimated capital cost of a Green Line Medford Hillside extension is $88 million. By comparison, capital costs for the Blue Line extension to Medford Hillside would be $548 million (which would include $138 million for the Red Line - Blue Line Connector). The Charles–Medford Hillside segment alone would cost $411 million, or $323 million more than a Green Line extension to Medford Hillside.

The largest component ($140 million) of the difference in cost between the Blue and Green Line extensions is the additional 0.8 mile length of the Blue Line extension, all of which would be in a tunnel under the Charles River. Another $55.5 million is attributable to the purchase of 50 new Blue Line cars for the extension, compared to only 10 new LRVs for a Green Line extension. The Blue Line extension also includes a related cost of $37.5 million for a new equipment maintenance facility near Lechmere, because the present Blue Line shops could not accommodate an additional 50 cars. Existing Green Line shops and a new

Figure 8-6
Green Line Extension to Medford Hillside



Lechmere facility planned independently of a Medford extension could service the 10 additional Green Line cars. Finally, construction costs for rapid transit stations are higher than for surface Green Line stations.

Net operating costs would increase by $2.1 million, including $1.3 million in savings from the rerouting of bus service in Somerville and Medford. Such rerouting would include reductions in frequency on parallel bus lines and changes in the terminal of some routes serving stations such as Lechmere and Davis.

Air Quality Impacts

A Green Line extension to Medford Hillside would provide moderate air quality benefits, reducing regional emissions by 0.06 percent, at a relatively low cost ($1.9 million per kilogram of VOC eliminated per weekday).

Blue Line - Red Line Connector

The Red Line - Blue Line Connector would consist of an extension of the Blue Line from its present inner terminal at Bowdoin Square via a subway under Cambridge Street to Charles Station on the Red Line (See Figure 8-7). This short extension would provide a direct transfer connection between the Red and Blue Lines, which would provide better distribution for trips starting on both lines, including improved travel to Logan Airport.

A Blue Line extension from Bowdoin to Charles would attract an estimated 19,210 new riders to the Blue Line, including 4,970 new transit riders. The Red Line - Blue Line Connector is one of the better rail expansion projects examined for the PMT in terms of capital cost per new weekday transit rider ($27,700), annual cost per hour of travel time saved ($4.73), and capital cost per weekday kilogram of VOC eliminated ($3.2 million). It would also provide a moderately high reduction in regional emissions of 0.05 percent. The capital cost of the extension would be $137.5 million.

In more detail, impacts would be as follows:

Ridership Impacts

A Red-Blue Connector alone would carry 19,210 total riders and 4,970 new transit trips per weekday. This represents a relatively large increase in new transit trips, and compared to other PMT projects, would be exceeded only by significantly larger rail projects.

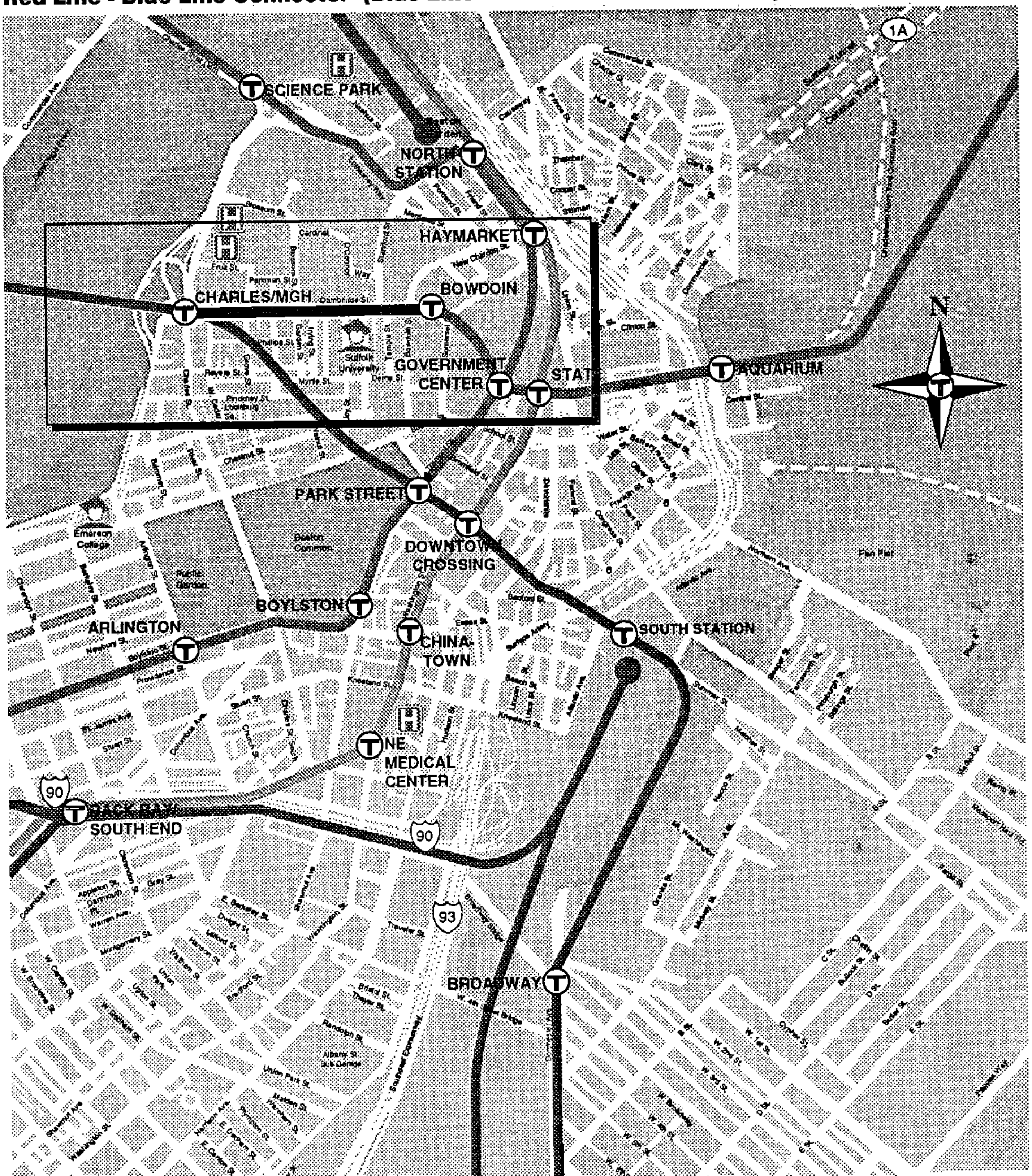
Costs and Cost-Effectiveness

Capital costs for a Red Line - Blue Line Connector would be $137.5 million. Capital costs per new weekday transit rider would be $27,700. This cost is low for a rail extension.

Air Quality Impacts

The Red Line - Blue Line Connector would provide moderate air quality benefits considering the size of the project, reducing regional emissions by 0.05 percent. The capital cost per kilogram of VOC eliminated per weekday would be low for a rapid transit project, and in the mid-range of all PMT projects, at $3.2 million.

Figure 8-7
Red Line - Blue Line Connector (Blue Line Extension to Charles/MGH)



Green Line Arborway Restoration/Replacement

Because of subway modifications required for the Type 7 Green Line cars and a scheduled re-paving project on Huntington Avenue, E Line service was suspended in December 1985. Substitute service was provided by new MBTA bus Route 39 from Arborway to Copley Square. E Line service resumed as far as Brigham Circle in the Summer of 1986. Because of delays in the paving project, E Line service between Brigham Circle and Heath Street did not resume until late in 1989.

Permanent bus replacement of "outer" E Line service between Arborway and Heath Street or Brigham Circle had been under consideration by the MBTA for years prior to the 1985 shutdown. Among the reasons was that the Southwest Corridor Orange Line relocation was expected to cause a large decline in outer E Line ridership. An extensive alternatives analysis for the E Line corridor was undertaken in 1987. E Line service has not resumed between Heath Street and Arborway, but there has been no decision to make the bus conversion permanent.

A major complicating factor in restoration of E Line service has been changes in federal laws pertaining to accessibility for people with disabilities. At present, no part of the Green Line is accessible. This can continue for the time being, because the service is already in place, but will need to be corrected with future improvements and vehicle purchases. Because of the length of time the outer E Line has been shut down, it would now be subject to regulations for new services. Hence, re-opening could not precede the design and procurement of accessible Green Line vehicles.

At present, E Line light rail service operates from Heath Street to Lechmere Station. Non-summer weekday headways are eight minutes peak, nine minutes mid-day, and 10 minutes evening. Two-car trains are run except in the evening. Additional short-turn service is run as needed from Northeastern University or Brigham Circle to the subway. The Route 39 substitute bus service for the outer E Line now runs from Forest Hills Station to Back Bay Station via Copley Square. Weekday headways are three to four minutes in peak hours and five to seven minutes at other times.

Two alternatives for Arborway service were examined in the PMT analysis. The first was the restoration of light rail service between Heath Street and Arborway/Forest Hills station (see Figure 8-8). The alignment would generally be the same as it was prior to the 1985 shutdown, except that cars would terminate at a new off-street loop at Forest Hills Station. (The right of way for this loop was constructed as part of the Southwest Corridor project, but has not had rails or a power system installed.) Bus Route 39 would be discontinued.

The second was the institution of a trackless trolley line from Arborway to Park Street as an alternative to restoring the Green Line. From Arborway/Forest Hills, the trackless trolley would follow the alignment of the Green Line tracks as far as the corner of Ruggles Street and Huntington Avenue. (The Green Line would continue to run as far as Heath Street, so the trackless trolley would offer parallel service between Heath and Ruggles.) The trackless trolley route would then turn right on Ruggles Street and follow the route of bus 43 through the South End along Tremont Street and around Boston Common to Park Street (see Figure 8-9). Route 43 would thus be subsumed by the trackless trolley and Route 39 would be discontinued. (This alternative could possibly be connected to Washington Street Replacement Service and/or the South Boston Piers Transitway as well.)

Figure 8-8
Green Line Arborway Restoration

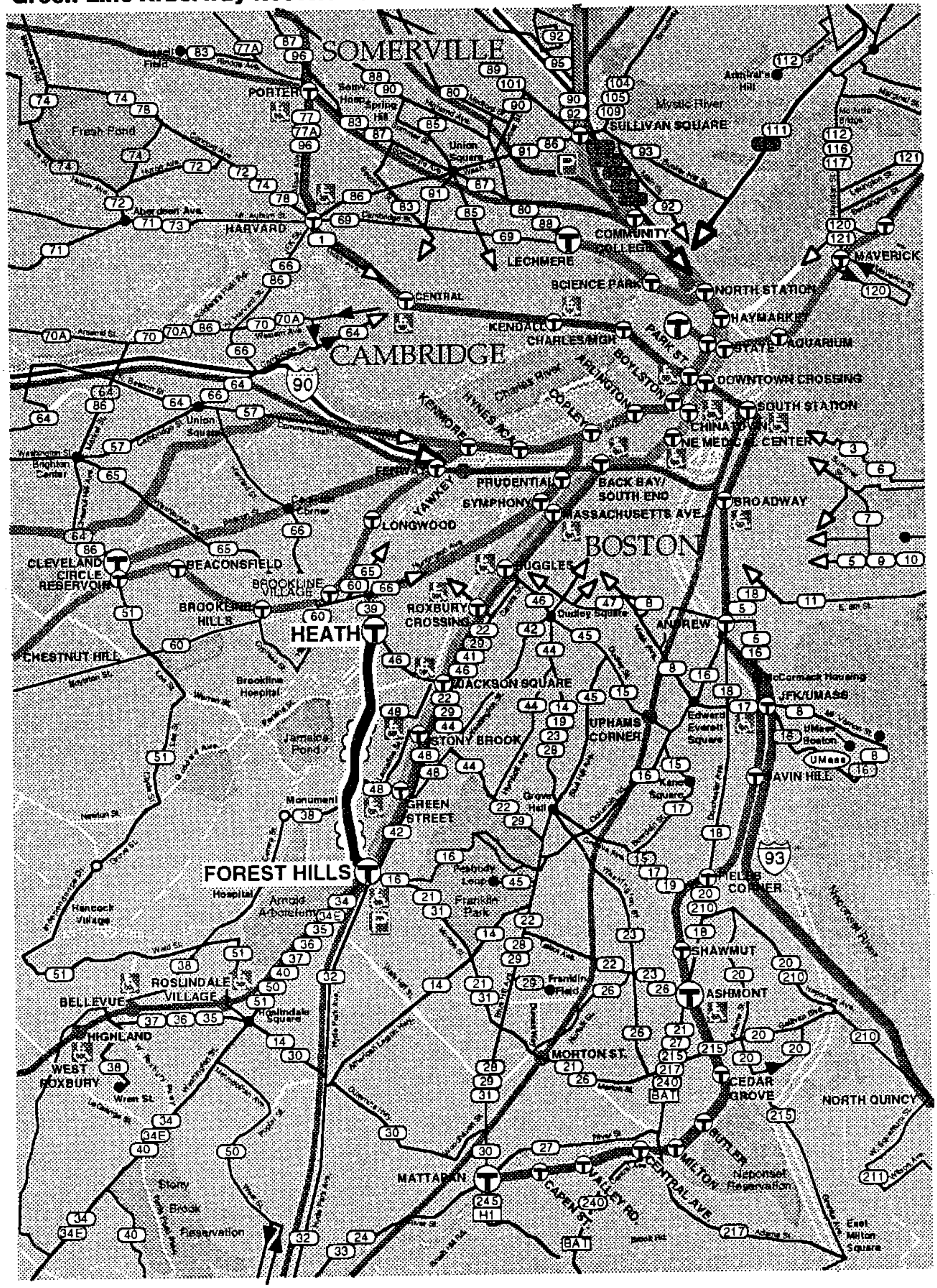
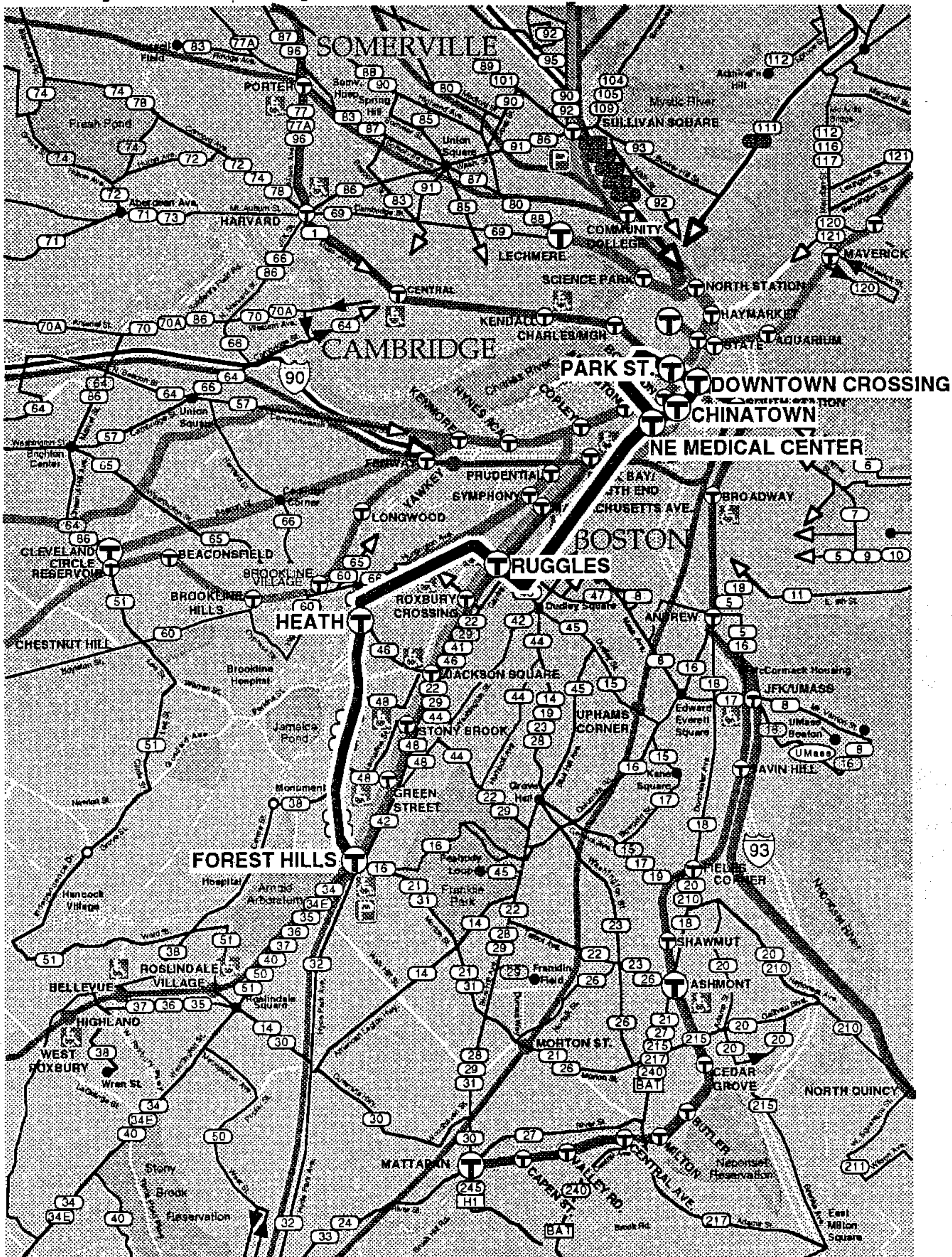


Figure 8-9
Arborway Trackless Trolley



Station stops along South Street, Centre Street and Huntington Avenue would be roughly the same as under the Green Line restoration. There would be somewhat fewer stops than currently exist for bus routes 39 and 43. Removing selected stops improves the running time of the service which has been estimated to be 32 to 35 minutes from Forest Hills to Park Street in the morning peak period. The fare structure assumed for the PMT would be the same as a local bus.[6] Headways would be five minutes during the peak hour.

The PMT analysis did not lead to clear conclusions with regard to either of these projects. Ridership on either service would be high (36,100 on restored Green Line service and 38,700 on Arborway trackless trolley service), but few new transit riders would be attracted (140 and 320 per weekday, respectively). However, both would make service significantly more convenient for existing riders. Also, Green Line restoration would return a one-vehicle ride to passengers traveling between outer E Line stops and Central Subway points east of Copley Station, and the trackless trolley alternative would offer a one-vehicle ride to Park Street and upgraded service to the South End. Both services would result in significant operating cost savings of up to $2.6 million. The regional air quality improvement would be small, but within the E Line corridor, the improvement from reduction of diesel bus mileage could be significant.

The PMT analysis leads to the conclusion that Arborway Restoration/Replacement should continue to be considered as a high priority, but that these alternative services, such as trackless trolley, should be evaluated further using new criteria suited to the unique characteristics of the corridor. In addition, it will be very important to continue the ongoing dialogue with the Arborway community to ensure that the interests of all relevant parties are accounted for.

In more detail, the impacts of the two alternatives were as follows:

Ridership

A restored E Line would carry 36,100 weekday riders per weekday in 2020. Only 140 of these would be new transit riders. The remainder would either be users of the portion of the E Line that is currently in operation or would be diverted from other MBTA services. The main source of diversions would be bus Route 39, which would be discontinued.

Travel time savings for the Green Line restoration would be relatively high at 691,600 hours per year. This places it at the top of the middle tier of projects, below the "megaprojects" such as the Inner circumferential transit line, the Blue Line extensions and the North-South rail connector.

The Arborway Trackless Trolley would carry 38,690 weekday riders per weekday in 2020. Only 320 of these would be new transit riders. Like the Green Line restoration, the remainder would be people using other transit services including the present Green Line, the 39 bus and the 43 bus.

Travel time savings for the trackless trolley would be lower than for the Green Line, at 360,900 hours per year. This level of savings puts the trackless trolley in the mid-range of PMT projects.

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[6]Another possibility would be to have a local bus fare for surface only trips and a rapid transit fare for trips including a transfer to a subway line.

Costs and Cost-Effectiveness

The estimated capital cost for restoration of E Line service to Forest Hills is $56.6 million. Of this, approximately $15 million is for reconstruction of fixed facilities, including tracks and power supply. The remainder is for purchase of low-floor light rail vehicles for the line. Because most of the passengers on the extension would be base-case transit users, the cost per new transit rider would be very high, at $417,400.

Extending all E Line trains from Heath Street to Forest Hills on present headways, combined with elimination of Route 39, would result in a net operating cost reduction of $1,484,000 per year. This would be the combined result of an increase of $5,038,000 in Green Line operating costs, but a reduction of $6,522,000 in bus operating costs. The saving would be smaller if an increase in E Line frequency was required, but it appears that projected ridership could be accommodated with the existing headways.

The cost for building the Arborway Trackless Trolley ranges between $15 million and $27 million, depending on what type of vehicles would be used. Costs for the trolley infrastructure are in the range of $8 to $9 million. These are relatively low, given the length of the line, because the existing trolley poles and power system from Heath Street to Arborway could be reused for the trackless trolley. Thirty vehicles would be needed for the service given the five-minute headways. Forty-foot trackless trolleys similar to the ones in use in Cambridge cost $210,000 each, while 60-foot articulated trolleys, like those proposed for use in the South Boston Transitway, cost roughly $630,000 each. This cost differential is the reason for the range in total project cost given above.

The capital cost per new weekday rider would be relatively high, between $42,600 and $85,400 depending on the vehicles, because of the small number of new trips produced by the project. It is comparable to several other fixed route projects such as the Blue Line extensions and the Green Line extension to Oak Square, and it is less than one-fifth the cost of the Green Line Arborway restoration. The capital cost per total rider would be the lowest of all the fixed route extensions ($388-698), less expensive even than express bus service from 128.

Like the Green Line restoration, the Arborway Trackless Trolley would result in a reduction of operating costs. The replacement of the two bus routes with the trackless trolley yields a net savings of $2.55 million annually: the trackless trolley would cost $5.5 million to operate, but bus Route 39 costs $6.5 million and Route 43 costs $1.5 million. If Route 39 were retained with reduced service, the savings would be less.[7]

Air Quality Impacts

Because most of the riders on the E Line restoration and the Arborway Trackless Trolley would come from existing transit services rather than from automobiles, the air quality benefits would be very small (less than a 0.01 percent reduction in weekday emissions for either project).

The elimination of bus Route 39 would reduce bus miles by 1,875 on weekdays, 1,547 on Saturdays, and 1,310 on Sundays. This would produce additional air quality benefits not accounted for. The elimination of Route 43 would reduce bus miles by 472 miles on weekdays, 388 miles on Saturdays and 291 miles on Sundays.

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[7]With 15-minute daytime headways, 30 minutes in the evening and 20 minutes on weekends, annual savings would be reduced to $721,000.

Accessibility and Traffic Flow

There are several complicating factors involved with service between Heath and Arborway, the primary one being accessibility requirements contained in the Americans with Disabilities Act. Accessibility has serious implications for the Green Line, even beyond the necessity to operate the service with low-floor vehicles. Current designs for low-floor cars maintain a height of 10 to 14 inches above the top of the track (similar to the height of the first step in the present Green Line vehicles). In order to have level access, the Green Line vehicles would have to stop at platforms the same height as the low floor. For the branches in street reservations this is not a serious problem, but for the E line beyond Brigham Circle, this is much more difficult since it runs unprotected in the middle of the street.

In order to be accessible to people in wheelchairs, the Green Line tracks would have to cross from the middle of the street to the sidewalk, which would be raised to the proper height. Such weaving across lanes on congested South Huntington Avenue, Centre Street and South Street would have severe impacts on traffic flow. Relocating all of the trackage next to the sidewalk would alleviate the traffic problems, but would eliminate all of the on-street parking in the busy commercial districts of Jamaica Plain. Weaving tracks would present a serious hazard for bicyclists and an uncomfortable ride for automobiles. Tracks in the street also cause the road surface to deteriorate more quickly.

The trackless trolley scheme would mitigate many of these problems. Low-floor or lift-equipped trackless trolleys are more readily available than low-floor light rail cars, and thus the service could begin earlier. The flexibility of the trackless trolleys would allow them to flow with traffic more smoothly. The current tracks in the street could be removed, allowing for safer, smoother rides as well as reduced maintenance costs.

Differing Service Areas

Although the Green Line restoration and the Arborway Trackless Trolley both serve the area in Jamaica Plain formerly served by the E Line, they are not the same service. The Green Line restoration provides direct, no-transfer service to Huntington Avenue, into the Central Subway and out to Lechmere. The Trackless Trolley would reach Park Street as its final destination via the South End. People traveling to the South End from Jamaica Plain would get more direct service and people in the South End would receive a higher level of service than they now receive. However, Jamaica Plain residents who want to get to inner Huntington Avenue, Copley, Arlington, Boylston, or any of the Green Line stations north of Park Street would have to transfer. Of course, transfers are now necessary for most of those destinations since the 39 bus terminates at Copley.

Chapter 9
Additional Expansion

This chapter describes the additional expansion that is recommended beyond the SIP and CA/T Mitigation expansion projects. Due to the high cost of maintaining the existing system, meeting ADA requirements, and implementing SIP and CA/T Mitigation projects, the availability of the additional funding that would be necessary for additional expansion is uncertain. This is especially true in the short-term, but it is also expected that the potential for long-term expansion will be limited. <u>Therefore, all of these recommendations are contingent upon funding availability and should be considered as part of EOTC's Capital Finance Review Committee's agenda.</u>

Projects that would generate the highest number of new transit trips, be the most cost-effective in attracting new ridership and improving air quality and have the most positive benefit on the operating deficit are recommended as "Additional Expansion" projects. These projects are presented in three groupings:

Short-Term This category contains lower cost projects that could be implemented by 2000. Other than additional park and ride expansion, which is a compilation of a large number of small projects, the costs of these projects are each below $50 million. The bulk of the capital costs are for equipment purchases and parking construction, both of which can be accomplished relatively easily in the short run.

Long-Term Tier 1 This category generally contains the projects that have the potential to provide the greatest increases in transit ridership. Three of these projects—the North Station - South Station Rail Link, Inner Circumferential Transit, and an extension of the South Boston Piers Transitway—are among the most expensive in the PMT. The Rail Link and Inner Circumferential Transit, as well as most other projects in this category, would require a full environmental review. Circumferential Transit would also require further study of alignment, technology, and costs. It is appropriate that these projects be considered as long-term projects because of the amount of time needed to complete the required environmental processes and the need to identify funding.

Long-Term Tier 2 Projects that are included in this category ranked moderately well in terms of ridership, cost, cost-effectiveness relative to other projects, but not as well as those in Tier 1. Some of these projects require additional definition before they can proceed, including the connections to Logan Airport and the Route 128 bus service. This latter

project would involve a significant amount of participation from the private sector but would provide a significant improvement in transit service to suburban locations.

By category, these projects are as follows:

Short-Term

- Commuter Rail Express Service
  - Rockport/Ipswich Line
  - Haverhill/Reading Line
  - Lowell Line
  - Franklin Line
  - Attleboro/Stoughton Line
- Inner Circumferential Bus Service
- Park and Ride Expansion (beyond SIP & CA/T requirements)
- Intercept Stations along Major Highways
- New/Improved Express Bus Services
- Better Downtown Boston Bus Distribution

Long-Term Tier 1

- Park and Ride Expansion (beyond SIP & CA/T requirements)
- Intercept Stations along Major Highways
- Rockport/Ipswich Commuter Rail/Blue Line Connection
- Inner Circumferential Transit Line
- South Boston Piers: South Station to Boylston
- North Station - South Station Rail Link
- Needham Commuter Rail Improvements/New Stations
- Green Line Improvements

Long-Term Tier 2

- Blue Line Extension to Lynn
- Red Line to Mattapan
- New Bedford/Fall River Commuter Rail Extension
- Commuter Rail to Millis
- Fairmount Commuter Rail/Red Line Connection
- New Connections to Logan Airport
- Route 128 Bus Service

Short-Term Projects (through 2000)

Commuter Rail Express Service

The operation of faster commuter rail service would make commuter rail travel times more competitive with, and in some cases, faster than automobile travel times. This, in turn, would attract more riders to commuter rail. Commuter rail travel times could be improved by operating express service and running trains at higher speeds. The PMT examined combinations of faster maximum operating speeds (70 miles per hour[1]) and express service on all lines. This would reduce travel times as shown in Table 9-1.

Table 9-1
Commuter Rail Running Times with 70 MPH Operation
(to/from End of Line in Minutes)

	Existing Local	Existing Express	70 MPH Local[1]	70 MPH Express[1]
Rockport	66	—	58	—
Ipswich	55	—	50	—
Haverhill	68	—	61	45
Lowell	49	—	40	33
Fitchburg	91	85	88	72
Framingham	50	—	44	40
Needham	44	—	41	27
Franklin	66	54	66	54
Providence	69	59	69	50
Stoughton	37	—	33	—
Fairmount	19	—	19	—

The operation of express trains with higher maximum operating speeds and high levels of service is recommended on four lines: Rockport/Ipswich, Haverhill/Reading, Lowell, and Franklin. In addition, faster service will be required on the Attleboro/Stoughton Line so that commuter rail service will not interfere with planned high speed Amtrak service.

Faster service on the Rockport/Ipswich Line would increase ridership by 2,150 trips per weekday, of which 68 percent would be new transit trips. The capital cost of $18.6 million would be low relative to the number of new transit trips attracted and the resulting air quality benefits (a 0.04 percent reduction in regional emissions.

On the Haverhill/Reading Line, the operation of more frequent service to and from Haverhill, faster operating speeds, and the operation of express trains would increase ridership by 4,540 trips per weekday, including a diversion of 2,890 trips from automobiles to commuter rail. Both of these increases are high compared to other improvements to existing services. The reduction in regional emissions, at 0.10 percent, is also relatively high. Capital costs, in

[1]Except 100 MPH for the Attleboro/Providence Line.

On the Lowell Line, the institution of faster service and express trains could attract significant ridership increases while reducing operating costs. These improvements are among very few analyzed in the PMT that would reduce, rather than increase, the operating deficit. Operating subsidy could be reduced by up to $1,253,000 per year and ridership increased by up to 3,200 new trips per weekday. The capital costs of the improvements would be $17.1 million. The capital cost per new transit rider ($5,330 to $6,660) would be very low compared to other projects. Air quality benefits would be relatively high, at 0.08 to 0.10 percent reduction in regional emissions.

On the Franklin Line, there is also the potential to generate significant ridership increases (up to 2,580 total trips and 1,245 new transit trip per weekday) through the operation of faster service, including more express service, on the Franklin Line. Further, these improvements could provide modest air quality benefits (a 0.03 percent reduction in regional emissions). The capital cost per new weekday rider ($36,800) would be among the higher of such costs for commuter rail improvements.

Additional information on the Rockport/Ipswich, Haverhill/Reading, Lowell, and Franklin Lines is as follows:

Rockport/Ipswich Line

Currently, the two branches of the Rockport/Ipswich Line serve 16 stations (see Figure 9-1) In addition, one private station—Riverworks—is served by nearly half of all trains. During the AM peak, three inbound trains on the Rockport branch provide service at 25 to 104 minute headways, and four trains on the Ipswich branch provide service at 30 to 50 minute headways. One train also operates inbound from Beverly Depot. Most peak period Ipswich branch trains stop at all intermediate stations, but some Rockport branch trains run express south of Salem. Service is relatively frequent at stations served by both branches—Beverly Depot, Salem, Swampscott, Lynn, and Chelsea—with headways of less than 30 minutes. PM peak outbound service generally mirrors AM peak inbound service.

The recommended service improvements involve track and right-of-way improvements to increase the maximum operating speed to 70 mph, the operation of peak period express trains on the Rockport branch, and increases in service levels. During peak periods, Rockport branch express trains would make all stops from Rockport to Salem (see Figure 9-2), and then run express to North Station. Ipswich branch trains, which would stop at all stations, would provide service to stations on the shared portion of the line from Swampscott south. Passengers making interzone trips from Rockport branch stations north of Beverly to stations south of Salem would transfer at Beverly Depot or Salem. Peak period service on both branches would be operated at 30 minute headways. This service configuration would result in 15 minute headways at Beverly and Salem, and 30 minute headways at all other stations. Compared to current operations, service would be more frequent at all stations on both branches from Salem northward, and slightly less frequent at Swampscott, Lynn, and Chelsea.[2]

During off-peak periods, schedules would remain similar to the present ones.

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[2]From Lynn, when relative access times to express bus routes and commuter rail are considered, express buses provide shorter total travel time than commuter rail. For this reason, an increase in service at Lynn station was not deemed to be necessary.

Figure 9-1
Existing Rockport/Ipswich Line Service

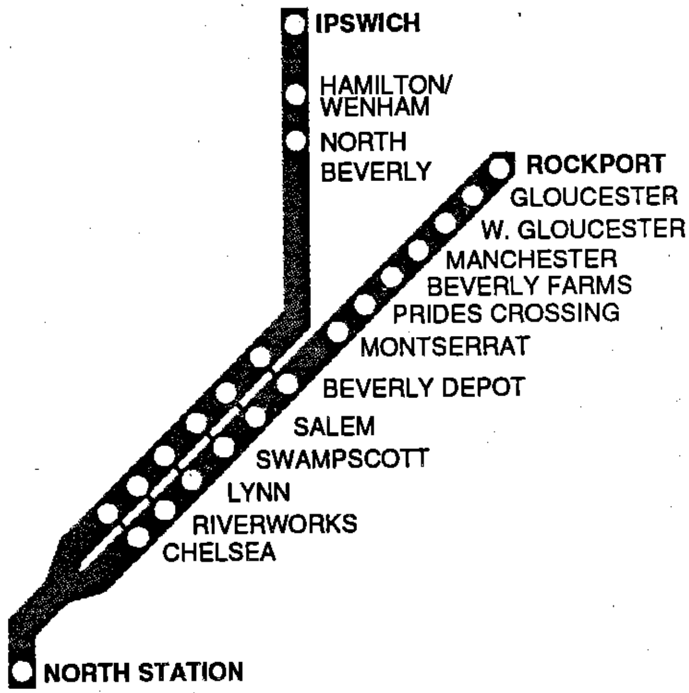
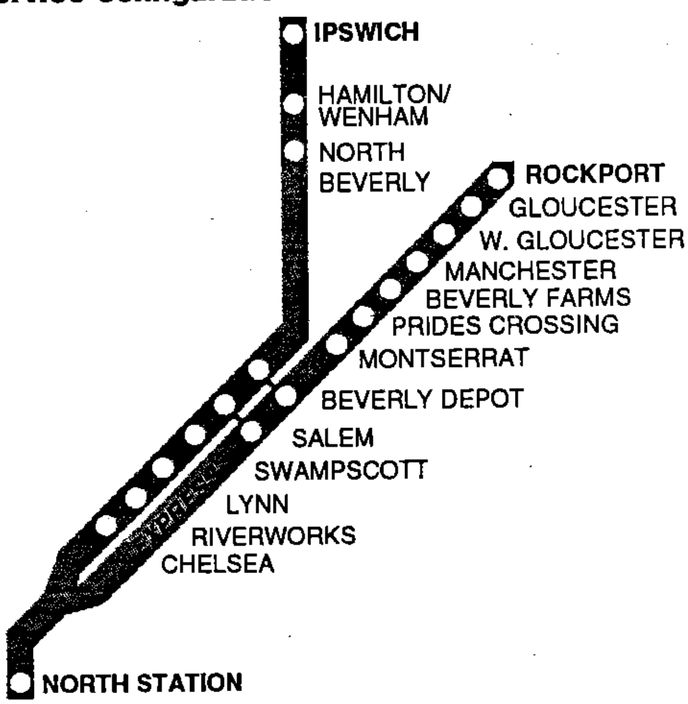


Figure 9-2
Express/Local Service Configuration



The operation of service with higher maximum speeds and express trains would reduce travel times by five to eight minutes for most trips, or by nine to 42 percent on express trains, and up to 23 percent on local trains. Travel times from Rockport would be reduced from 66 minutes to 58 minutes on express trains, and from Ipswich, from 55 to 50 minutes.

Service operated in this manner would increase ridership on the two branches of the existing line by 2,150 trips per weekday, including 1,460 new transit trips. The capital costs of existing line improvements ($18.7 million) would be low relative to the number of new transit riders and the projected air quality benefits (a 0.04 percent reduction in regional emissions). The number of new trips and the air quality benefits would be the same as for a Newburyport extension, but the capital and operating costs would be significantly lower.

In more detail, impacts would be as follows:

Ridership

Faster service, including the operation of express trains, would increase ridership on the two branches of the existing line by 2,150 trips per weekday. Of these trips, 1,463, or 68 percent, would represent new transit trips. This is the third-highest number of new transit riders that could be attracted by improved commuter rail service (after similar improvements on the Haverhill/Reading, and Lowell Lines).

Costs and Cost-Effectiveness

The right-of-way on the existing Rockport/Ipswich Line is in generally good condition, but the DPU has imposed a number of speed restrictions at grade crossings. To operate service at higher speeds, crossing protection would need to be improved at six intersections at a cost of approximately $1.6 million. In addition, two new trains set would be required to operate faster service with express trains on the Rockport branch ($17.1 million for two locomotives and 12 cars). This would result in a total capital cost of $18.6 million.

The improved service would increase operating costs by $1.2 million per year. Of this, 73 percent, or $0.9 million would be recaptured in increased fare revenue. The capital cost per new transit rider of $12,700 for the existing line improvements is low compared to other rail projects.

Air Quality Impacts

The new transit ridership attracted by the improved serve would reduce regional emissions by 0.04 percent. The capital cost per kilogram of VOC eliminated per day would be $608,300 for existing line improvements. This cost per air quality benefit received is low in comparison to most PMT projects (with the only exceptions being existing line improvements on the Lowell and Haverhill/Reading lines).

Haverhill/Reading Line

Currently, the Haverhill/Reading Line serves 14 stations between Haverhill and North Station (see Figure 9-3). During the AM peak, five of seven inbound trains operate the full distance of the line from Haverhill to North Station; the other two operate only from Reading.[3] Headways from Haverhill range from 24 to 57 minutes, and from Reading range from 20 to 36 minutes. In the PM peak, three of six outbound trains operate to Haverhill, while the other three terminate at Reading. Headways to Haverhill are 45 to 60 minutes, and headways to Reading are 15 to 45 minutes.

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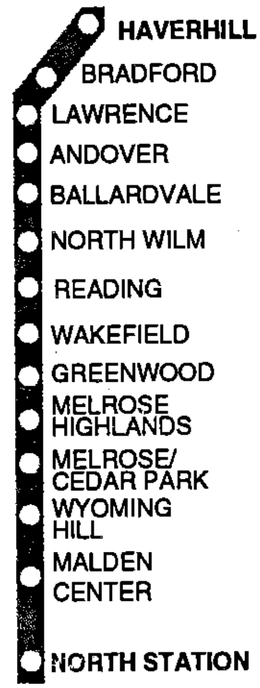
[3]One of these two trains has bus connections from all stations north of Reading except North Wilmington.

Figure 9-3
Existing Haverhill/Reading Line Service



Most off-peak and non-peak direction trains operate only between Reading and North Station (23 of 31 trains).[4] Off-peak service to and from Reading operates at approximately 30 to 90 minute headways.

Service improvements on the existing line would consist of track and right-of-way improvements to increase the maximum operating speed to 70 mph, the operation of increased levels of service, and peak period express trains.

During peak periods, express trains would serve Haverhill, Bradford, Lawrence, Andover, Reading, Wakefield, and Malden Center stations. Local trains would make all stops between Haverhill and North Station (see Figure 9-4). Express and local trains would both operate at 30 minute headways. This would result in 15 minute headways at stations served by express trains, and 30 minute headways at all others. Compared to current operations, service frequencies would be similar at stations from Wyoming Hill to Reading, but much more frequent north of Reading. During off-peak periods, service would remain about the same as at present.

The operation of service with higher maximum speeds and express trains would reduce travel times by 14 to 24 minutes, or by 34 to 54 percent on express trains, and by 10 to 36 percent on local trains (see Table 9-2).

The ridership, cost, and air quality impacts would be as follows:

[4]Two outbound off-peak trains have bus connections to all stations north of Reading except North Wilmington.

Figure 9-4
Haverhill/Reading Line Express/Local Service Configuration w/o Extension

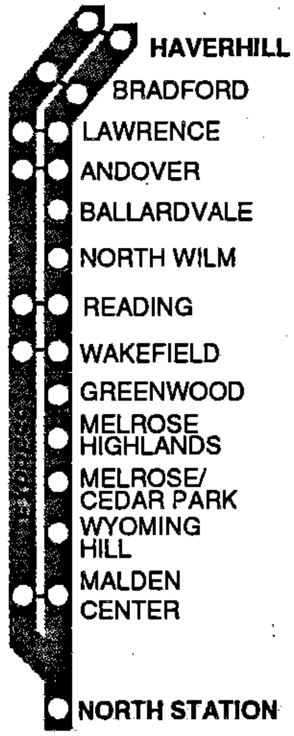


Table 9-2
Faster Haverhill/Reading Line Service: Travel Times to North Station (in minutes)

	Existing Service	Future Local	Future Express
Haverhill	68	61	45
Bradford	66	59	42
Lawrence	57	50	34
Andover	52	45	28
Ballardvale	48	40	—
N. Wilmington	41	34	—
Reading	32	28	16
Wakefield	26	23	12
Greenwood	23	20	—
Melrose Highlands	20	16	—
Melrose-Cedar Park	18	14	—
Wyoming Hill	16	11	—
Malden Center	11	7	—

Ridership

Faster service, including the operation of express trains, would increase ridership on the existing Haverhill/Reading Line by 4,540 trips per weekday. Of these trips, 2,890, or 64

percent, would represent new transit trips. This would be the largest number of new transit trips attracted to any existing commuter rail line through the operation of faster service and express trains.

Costs and Cost-Effectiveness

The Haverhill/Reading right-of-way consists of a mix of single and double track. While there could be some scheduling constraints, the assumed increases in service could be operated within the existing right-of-way. Instead, the major operating constraint on this line is a number of closely spaced grade crossings in Melrose and Wakefield, where the Department of Public Utilities (DPU) limits trains speeds to 30 mph (in Melrose) and 15 mph (in Wakefield). Crossing circuits can be installed at these locations that would provide reasonable assurance that cars would not stop on the tracks. This would cost of up to $5.0 million, with subsequent DPU approval for higher speeds required.[5] In addition, four new train sets would be required to operate the increased service levels and faster service with express trains, at a cost of $34.1 million (for four locomotives and 24 cars). This would increase the total cost to $39.1 million.

The service improvements would increase operating costs by $2.3 million per year, of which 62 percent ($1.4 million) would be recovered in increased fare revenue.

Air Quality Impacts

Improvements to the existing Haverhill/Reading Line would reduce regional emissions by 0.10 percent. This is among the largest air quality benefits for improvements to an existing service. The capital cost per kilogram of VOC eliminated per day would be $484,800 for existing line improvements. This cost is low compared to most other rail improvements.

Lowell Line

Currently, the Lowell Line serves eight stations: Lowell, North Billerica, Wilmington, Mishawum, Winchester, Wedgemere, West Medford, and North Station. Service generally operates at 30 minutes headways during peak periods and at 60 minutes during off-peak periods.

Service improvements would consist of an increase in the maximum operating speed to 70 mph, the operation of express trains during peak periods, and the doubling of service from Mishawum Station.

Peak period express trains would provide service from Route 128 and beyond, making all stops from Lowell to Mishawum (Lowell, North Billerica, Wilmington, and Mishawum), and then running express to North Station (see Figure 9-5). Peak period local trains would operate between Mishawum and North Station, and provide service to Mishawum, Winchester, Wedgemere, and West Medford. Both local and express service would be operated during peak periods at 30 minute headways. This would mean that a similar level of service would be maintained from all stations, with the exception of Mishawum, where service would be doubled. Passengers making interzone trips from stations north of Route 128 to stations south of Route 128 would transfer at Mishawum. During off-peak periods, local service would continue to be operated in its present fashion.

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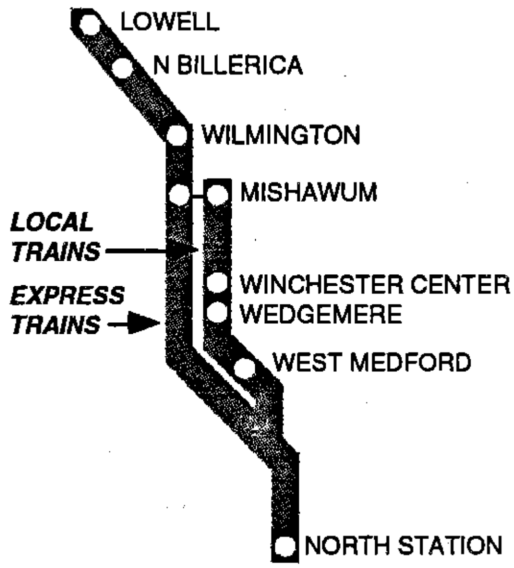
[5]Although not examined, another alternative for Haverhill service that would avoid these at-grade crossing would be the use of the Lowell Line to Wilmington, and then the Wildcat branch over to the Haverhill Line. (This is the routing assumed for Haverhill service with a North Station - South Station Rail Link).

Figure 9-5
Lowell Line Express/Local Service Configuration



The operation of express trains with 70 mph maximum speeds would reduce travel times significantly—from 33 to 50 percent on express trains, and up to 23 percent on local trains (see Table 9-3).

Table 9-3
Faster Lowell Line Service: Travel Times to North Station (in minutes)

	Existing Service	Future Express	Future Local
Lowell	49	33	—
N. Billerica	41	27	—
Wilmington	32	19	—
Mishawum	26	13	20
Winchester	19	—	14
Wedgemere	16	—	12
W. Medford	12	—	8

Ridership, cost, and air quality impacts would be as follows:

Ridership Impacts

Faster service, including the operation of express trains, would increase ridership on the existing line (between Lowell and Boston) by 4,600 trips per weekday, or by 31 percent. Of these trips, 2,560 would represent new transit trips.

Costs and Cost-Effectiveness

The right-of-way on the existing Lowell Line is in good condition and can already support faster service. As a result, the capital costs to run faster service with express trains are limited to the cost of the additional rolling stock required. Express service would require

two additional train sets (an increase from four to six), at a cost of $17.1 million (one locomotive and six cars each).

The improved service would generate $1.25 million per year more in fare revenue than operating costs would be increased, and thus reduce the operating deficit by a like amount. This would be due to the combination of two factors. First, service levels on the Lowell Line are already relatively high. Combined with faster running times, this means that relatively few additional service hours would be required to operate the assumed local/express service configurations, so that the additional operating costs would be low. Second, the running time improvements that could be implemented on the Lowell Line would be large enough to attract a significant number of new riders. Also, because the capital costs would be relatively low, the capital cost per new rider would be low, at $6,660.

Air Quality Impacts

Improvements to the existing line would reduce regional emissions by 0.08 percent. This is among the largest air quality benefit for improvements to existing services. The capital cost per kilogram of VOC eliminated per day for existing line improvements would also be among the lowest, at $243,100.

Franklin Line

The Franklin Line serves 16 stations (see Figure 9-6). Most trains serve all stations. Major exceptions are Plimptonville and Hyde Park. Plimptonville is served by only two trains per weekday, and most service to Hyde Park is provided by Attleboro/Stoughton trains and only two weekday Franklin Line trains. Also, during the AM peak, five of six inbound trains operate the full distance of the line from Forge Park/495 to South Station; the last AM peak inbound train operates only from Norwood Central and skips Hyde Park, Ruggles, and Back Bay. Finally, two of the five Forge Park/495 trains are express trains that skip Plimptonville, Norwood Depot, Islington, Endicott, Readville, and Hyde Park. Headways from Forge Park/495 range from 20 to 35 minutes.

In the PM peak, four of five outbound trains operate to Forge Park, while the other train terminates at Norwood Central. Headways to Forge Park are 30 to 70 minutes. Only one of the outbound trains is an express train; this train skips Hyde Park, Readville, Endicott, and Islington.

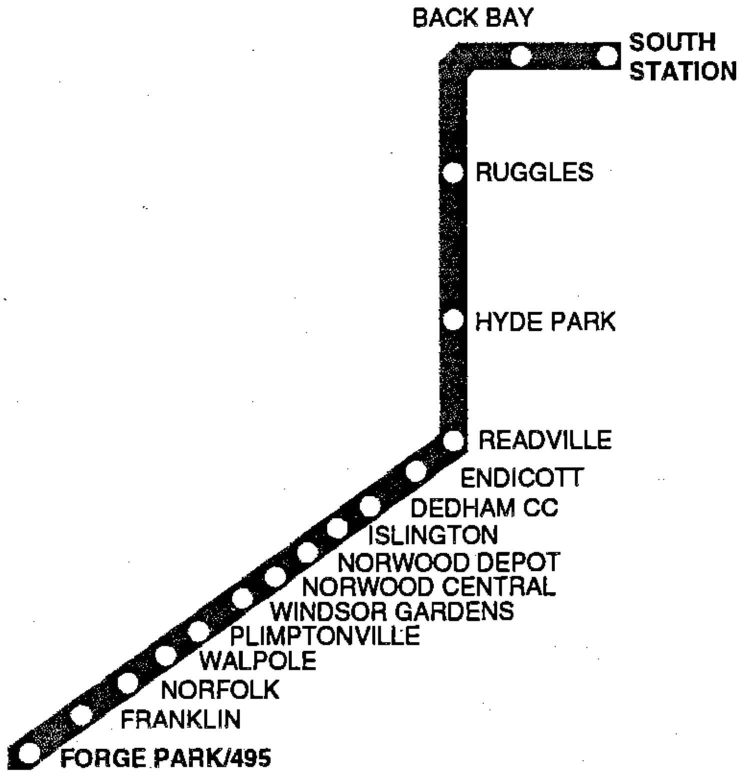
Most off-peak trains operate the full distance of the line. However, non-peak direction trains in the morning and afternoon skip many stops. Most midday trains stop at all stations except Hyde Park, and Plimptonville; some also skip Ruggles. Midday headways are approximately one to two hours.

Most outbound evening trains stop at all stations except Hyde Park, while most inbound evening trains skip many stops. Evening headways are approximately one to one and one-half hours.

The service improvements examined in the PMT consisted of track and right-of-way improvements to increase the maximum operating speed to 70 mph, the operation of increased levels of service, and peak period express trains.

During peak periods, express trains would serve the Franklin Line's highest ridership stations beyond Route 128: Norwood Depot, Norwood Central, Walpole, Norfolk, Franklin, and Forge Park/495. Local trains would also operate the entire length of the line and make

Figure 9-6
Existing Franklin Line Service



all stops (see Figure 9-7). Express and local trains would both operate at 30 minute headways. This would result in 15 minute headways at stations served by express and local trains, and 30 minute headways at stations served only by local trains. Compared to current operations, service frequencies would be similar at stations only served by local trains, but approximately twice as frequent at stations served by express trains. During off-peak periods, service would remain about the same as at present.

The operation of express service with a 70 mph maximum speeds would reduce travel times by up to 13 minutes, or by 15 to 20 percent from beyond Route 128, and by 10 to 36 percent on local trains. However, travel times would remain the same on local service. This is because the large number of closely spaced stations would prevent trains from reaching higher speeds than they do now.

Ridership, cost, and air quality impacts would be as follows:

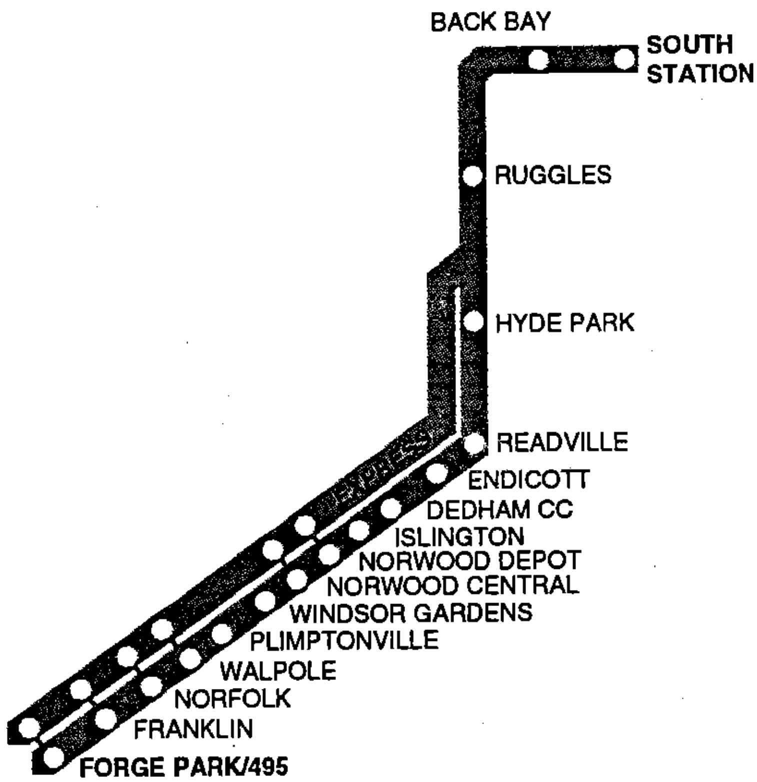
Ridership Impacts

Faster service, including the operation of express trains, would increase ridership on the existing Franklin Line by 2,580 trips per weekday. Of these trips, 1,250, or 48 percent, would represent new transit trips. These increases would be the third largest attainable through the operation of express service on existing lines (after the Haverhill/Reading and Lowell lines).

Costs and Cost-Effectiveness

The Franklin right-of-way consists of a mix of single and double track. While there could be some scheduling constraints, the assumed increases in service could be operated within

Figure 9-7
Franklin Express/Local Service Configuration



the existing right-of-way. The major right-of-way improvement that would be required to provide faster service would be the relocation of the Franklin layover facility to Bellingham, which would cost approximately $20 million. In addition, the operation of express and local trains the full length of the line with a higher level of service would increase the number of train sets required from six to 10. However, service is now operated with nine-car train sets; with more frequent service, this could be reduced to seven-car train sets. Therefore, the total increase in rolling stock required would be four locomotives and 16 cars, at a cost of $25.8 million. The total cost of right-of-way improvements and rolling stock would be $45.8 million.

The capital cost per new transit rider for Franklin Line express service would be $36,800. This is among the higher of such costs for improvements to existing commuter rail lines. Nearly half of it is attributable to the relocation of the Franklin layover facility. The current layover facility does not have enough capacity even for current needs, and trains are restricted to 30 mph in its vicinity.

Franklin Line express service would cost $2.9 million per year to operate, and generate $0.7 million per year in new operating revenue. This would represent a farebox return for the new service of 21 percent, which is slightly low. The low farebox return is attributable to the large increase in operating costs, rather than low ridership. The Franklin Line currently has a slightly lower level of service than most other lines, and the PMT analysis assumed that service would be increased to a level more comparable with other lines. As a result, the increase in operating costs would be higher than for other lines. The PMT results show that the higher level of service would attract a significant number of new

riders (the third highest for express service, behind the Haverhill/Reading and Lowell lines), but that a level of service as high as that tested would not be justified. Ridership and cost impacts of a lower level of express service should be examined before implementation.

Air Quality Impacts

Improvements to the existing Franklin Line, including the operating of faster express service, would reduce regional emissions by 0.03 percent. This is third largest air quality benefit that could be achieved through the operation of express service on existing lines (after the Haverhill/Reading and Lowell lines). The capital cost per kilogram of VOC eliminated per day would be $1,724,000. This is among the higher of such costs for improvements to existing commuter rail lines.

Inner Circumferential Bus Service

For information on all alternatives for inner circumferential transit service, see the "Inner Circumferential Transit" portion of the Long-Term Tier 1 section of this chapter.

Park and Ride Expansion (beyond SIP and CA/T Mitigation Requirements), and Intercept Stations along Major Highways

A large number of park and ride expansion projects were examined as part of the PMT Update: over 21,000 new spaces at existing lots, 7,800 spaces at new intercept stations along major highways, as well as new parking with nearly all rapid transit, commuter rail, and express bus service alternatives. Both the SIP and CA/T Mitigation conditions require the expansion of 10,000 new spaces by the end of 1996 and 10,000 spaces by the end of 1999.

The PMT analysis indicates that park and ride expansion would be one the most cost-effective ways to divert a significant number of automobile users to transit for the majority of their trip. By 2020, there will be demand for more spaces than will be added to meet SIP and CA/T Mitigation requirements. To meet this demand, parking expansion beyond that required for SIP and CA/T Mitigation purposes is recommended.

Potential locations for parking expansion—both at existing lots and for new intercept stations—are the same as discussed in the "10,000 Parking Spaces by 12/31/96, and 10,000 Parking Spaces by 12/31/99" section of Chapter 8 (and additional detail is provided in Appendix G). As discussed in Chapter 8, there is a large degree of flexibility in determining which new lots could be constructed and/or expanded to meet the SIP and CA/T requirements. Much of the 1996 commitment will be met through the construction of the Old Colony Line stations; the remainder of the commitment could be met through new facilities on new services, new lots on existing lines, or the expansion of existing lots. The PMT analysis did not go as far as determining which specific park and ride expansion projects should be constructed to meet the commitment; this will require more detailed analysis than was possible within the scope of the PMT.

The costs that are presented for the various categories (by 1996, by 1999, and as additional expansion) are estimates developed by proportioning the total cost for all potential new expansion by the number of spaces in each category. This means that it will be possible to shift costs between years and categories as the expansion projects become better defined.

New/Improved Express Bus Services

The Boston region has in place an extensive network of radial rapid transit and commuter rail lines. However, as discussed below, there are a few gaps in the existing rail network within Route 128 that could be filled by instituting new express bus routes, as described below.[6]

New Express Bus Routes

New express bus services would be designed or revised to serve the same types of markets as rapid transit and commuter rail, which are also express-type services. These markets would include walk, drive, and, in some cases, feeder bus, access. This would differ from current operations in that most express bus routes are now designed primarily to serve local markets (i.e. walk access) only. The addition of new routes and the construction of park and ride lots along existing routes to attract those who live beyond walking distance of existing routes would increase the size of the markets served and increase ridership. For example, at rapid transit stations with parking, 20 percent of all riders drive and park at the station, and on commuter rail, 53 percent drive and park at the station. On express routes, with the exception of Route 300 (which has parking at Riverside), only eight percent drive and park near a stop (nearly all of which is at Newton Corner). If park and ride access on existing routes increased to 20 percent, as on rapid transit, the ridership increase on existing routes would be nearly 2,300 trips per weekday.

The new express routes, and associated park and ride lots, which are shown in Figure 9-8, would be as follows:

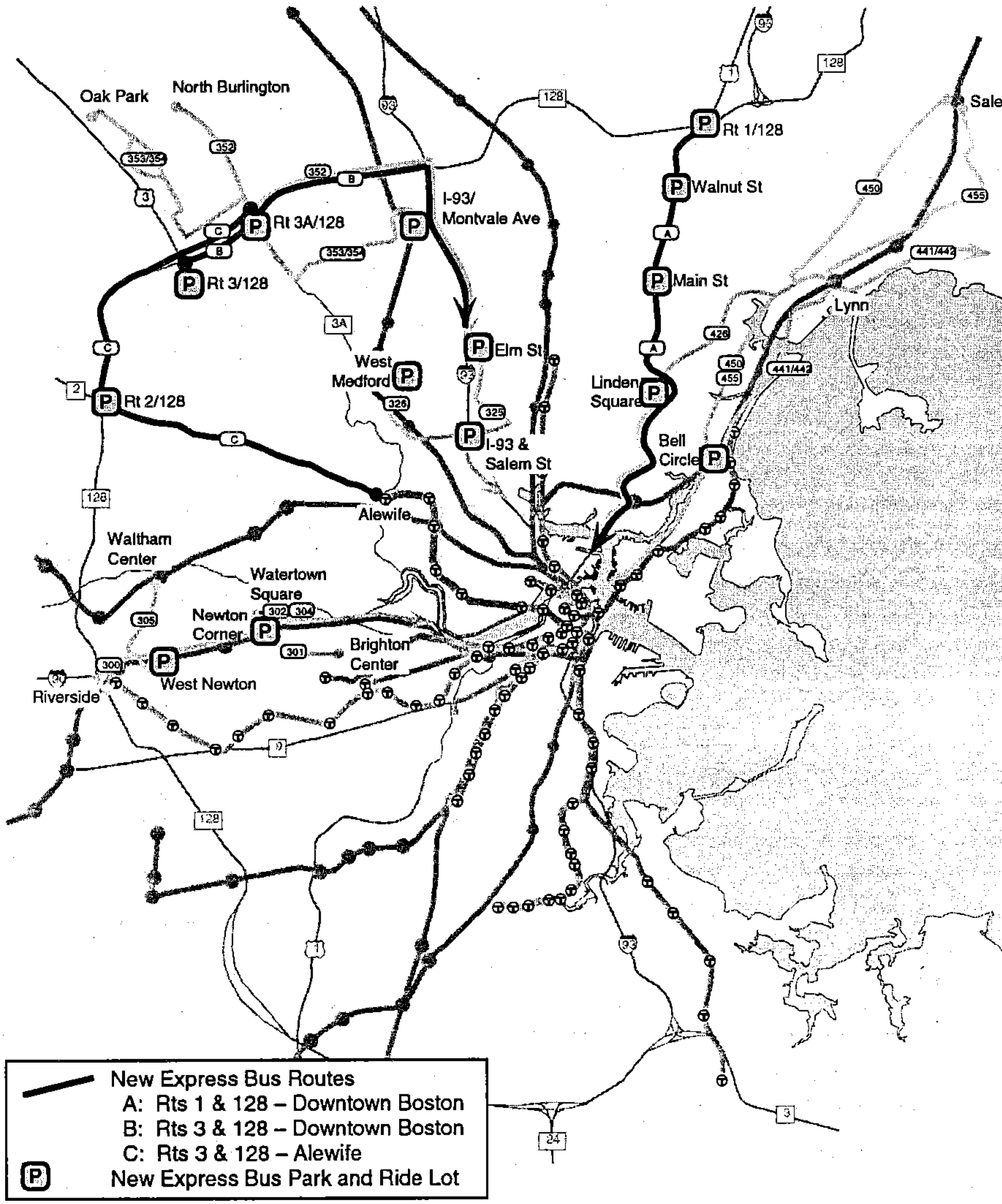
Lynnfield - Downtown Boston via Route 1
In the Route 1 corridor, an express route could be implemented from the vicinity of the intersection of Routes 1, 128, and I-95 in Lynnfield. It would operate via Route 1 to the Central Artery to the Haymarket exit, and then via local streets to Downtown Crossing and Government Center. Park and ride facilities would be located at the beginning of the line in Lynnfield, and then at the following Route 1 interchanges: Walnut Street in North Saugus, Main Street in Saugus, and Route 60 in Revere. This route is labeled as "Route A" in Figure 9-8.

Downtown Boston distribution would be via Haymarket Station, New Chardon Street, New Congress Street, Devonshire Street, Franklin Street, Washington Street, Court Street, Cambridge Street, and New Sudbury Street. Rapid transit connections would be provided with the Orange and Green lines at Haymarket Station, the Orange and Blue Lines at State Station, the Red and Orange lines at Downtown Crossing Station, and the Blue and Green Lines at Government Center Station.

During peak periods, service would operate at 15 minute headways. During off-peak periods, service would operate at 60 minute headways. Service would operate between 6:00 am and 7:00 pm.

[6]Existing MBTA express bus service operates to and from communities along and within Route 128. From beyond, express bus services are provided by private carriers. Based on this boundary, MBTA express bus services from beyond Route 128 were not considered.

Figure 9-8
New Express Bus Routes



Burlington – Downtown Boston via Routes 128 and I-93

A Burlington – Downtown Boston route would be designed attract those who now drive down Route 3 and from sections of Lexington and Burlington outside of Route 128. Inbound, it would begin at a park and ride lot at the intersection of Routes 3 and 128, operate along Route 128 to a park and ride lot at the intersection of Routes 3A and 128,[7] proceed along Route 128 and I-93 to a lot at Montvale Avenue and I-93, and then express to Boston via I-93. In Boston, it would provide the same distribution and rapid transit connections as the Lynnfield to Boston express route. This route is labeled as "Route B" in Figure 9-8.

During peak periods, service would operate at 15 minute headways. During off-peak periods, service would operate at 60 minute headways. Service would operate between 6:00 am and 7:00 pm.

Burlington – Alewife via Routes 128 and 2

A Burlington – Alewife route would be designed to serve similar origins as the Burlington to Downtown Boston route but destinations in Cambridge and other locations accessible via the Red Line. It would start at a park and ride lot at Route 3A and 128, travel to the stop at the Route 3 and 128 park and ride lot, then to the Route 2 and 128 lot, and then travel express to Alewife Station. This route is labeled as "Route C" in Figure 9-8

During peak periods, service would operate at 15 minute headways. During off-peak periods, service would operate at 60 minute headways. Service would operate between 6:00 am and 7:00 pm.

All three of the express bus routes examined would perform well, with total ridership of 2,470 to 3,140 total weekday trips, of which 1,940 to 2,360 would be new transit trips. Operating costs would be relatively low at $0.9 million or less per route, and farebox return ratios would be high, at 87 to 98 percent. Air quality benefits resulting from each individual route would be moderately low, but the combined impact of the three routes would be as high or higher than for many rail extensions.

In more detail, the impacts would be as follows:

Ridership

A new route between Burlington and Downtown Boston would carry the highest ridership, at 3,140 total trips and 2,360 new transit trips (see Table 9-4). The routes between Lynnfield and Downtown Boston and between Burlington and Alewife would each carry approximately 2,470 total trips, and 1,940 to 2,050 new transit trips. The relatively high ridership on the three new express routes would be due to the provision of park and ride lots along each route. This would allow the new express bus routes to serve a wider market than most of the existing express bus routes, which now primarily served those who are in walking distance of the route. Virtually all of the riders (over 99 percent) on the new routes would access the route via automobile and park at a park and ride lot, with the highest ridership at lots at or near the intersections of major highways. Total ridership by park and ride lot on each route would be as shown in Table 9-5.

Ridership on each of these routes compares favorably with ridership on existing express routes, which in September 1992 ranged from 500 to 4,200. The three new routes examined herein differ from existing express services in that parking would be provided; the lack of parking limits ridership on the existing routes.

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[7]This lot would also be served by Route 352.

Table 9-4
Ridership Impacts of Express Bus Improvements/Expansion

	Total Trips	New Transit Trips
A: Lynnfield – Downtown Boston via Route 1	2,470	1,940
B: Burlington – Downtown Boston via 128 and I-93	3,140	2,360
C: Burlington – Alewife via Routes 128 and 2	2,470	2,050

Table 9-5
Ridership by Park and Ride Lot

	Lynnfield - Boston (Rt. A)	Burlington - Boston (Rt. B)	Burlington - Alewife (Rt. C)
Routes 1, 128, and I-95, Lynnfield	1,420	—	—
Walnut Street at Route 1, North Saugus	610	—	—
Main Street at Route 1, Saugus	440	—	—
Route 60 at Route 1, Revere	0	—	—
Routes 3 and 128, Burlington	—	670	320
Routes 3A and 128, Burlington	—	290	180
Routes 2 and 128, Lexington	—	—	1,970
Montvale Ave @ I-93, Medford	—	2,180	—
Total	2,470	3,140	2,470

Ridership levels on the Burlington to Alewife route are somewhat surprising given that this route, unlike other express routes, would not take most riders close to their final destination, but would instead require a transfer to the Red Line. However, parking at bus park and ride lots would be free, so that the cost of a Zone 2 express bus pass ($72/month) would be significantly less expensive than the combined cost of parking at Alewife and purchasing a Subway Pass ($115/month). In addition, express bus travel times would be only slightly longer than automobile travel times to Alewife. As a result, it appears that the $4.00 parking charge at Alewife (which is the highest in the system)[8] may act as a deterrent to ridership in this corridor, and that an express bus route between Burlington and Alewife could attract a significant amount of the ridership deterred by the Alewife parking fee.

Costs and Cost-Effectiveness

All three of the express bus routes would be inexpensive to implement and to operate. Capital costs for the three routes would range from $3.1 to $4.4 million, with the majority of costs split between the new buses required and parking facilities:

[8]Parking fees at other rapid transit stations are $2.00, $2.25, or $2.50.

	Buses Req'd	Cost	Parking Spaces	Cost[9]
A: Lynnfield – Downtown Boston	6	$1.4m	1,100	$2.2m
B: Burlington – Downtown Boston	7	$1.6m	1,400	$2.8m
C: Burlington – Alewife	4	$0.9m	1,100	$2.2m

The capital cost per new rider would be $1,500 to $1,900. These costs are among the lowest among all PMT projects, with only the capital cost per new transit riders of better downtown Boston bus circulation being lower.

The three routes would increase operating costs by $0.5 to $0.9 million per year. Most of these costs would be offset by new fare revenue, and resulting farebox return ratios would be high on all three routes: 87 percent on the Lynnfield to Boston route, 94 percent on the Burlington to Boston route, and 98 percent on the Burlington to Alewife route.

Air Quality Impacts

Each of the three express bus routes would reduce regional emissions by 0.03 to 0.04 percent. Combined, the reduction would be 0.11 percent. The capital cost per kilogram of VOC eliminated each weekday would be $107,600 to $134,200. The total air quality benefits would be moderate, but the cost of achieving these benefits would be very low—lower than for any other projects except for better downtown Boston bus circulation.

Improved Express Bus Service in the Mass Pike Corridor

In addition to the implementation of new routes, improved integration of local and express routes in the Mass Pike corridor could improve express services in Newton and Waltham. At present, MBTA express and local bus routes in this area exist essentially as two separate systems. Express routes 300, 301, 302, 304, and 305 provide a high level of service, and are well utilized, while the local routes (52, 53, 54, 56, 58, and 59) provide low levels of service and are underutilized.

Much of the local service is already through-routed with Route 304.1 express service (Newton Corner–Downtown Boston). This includes nearly all trips on Routes 53 and 54, and most peak period service on Routes 56 and 58. However, through-routed local trips are not marked as Boston trips and have a low level of visibility. As a result, many potential riders are likely not aware of the through-routed service, and even for those that are, it can be difficult to know which trips are through-routed and which are not. Presumably for these reasons, the utilization of through-routed local service for trips to and from Boston is low—much lower than on the North Shore express routes or on Route 305. These problems could be solved by through-routing of all service on combinations of local and express routes and redesignating them as 300-series express routes. This would increase both the geographical reach of the express routes and the visibility of the services.

The PMT analysis examined five combinations of local routes combined with existing express service to create new express routes (see also Figure 9-9). These routes, which are listed below, would replace existing service on Routes 53, 54, 56, 58, 59 and 304.1, but not 304.0.[10]

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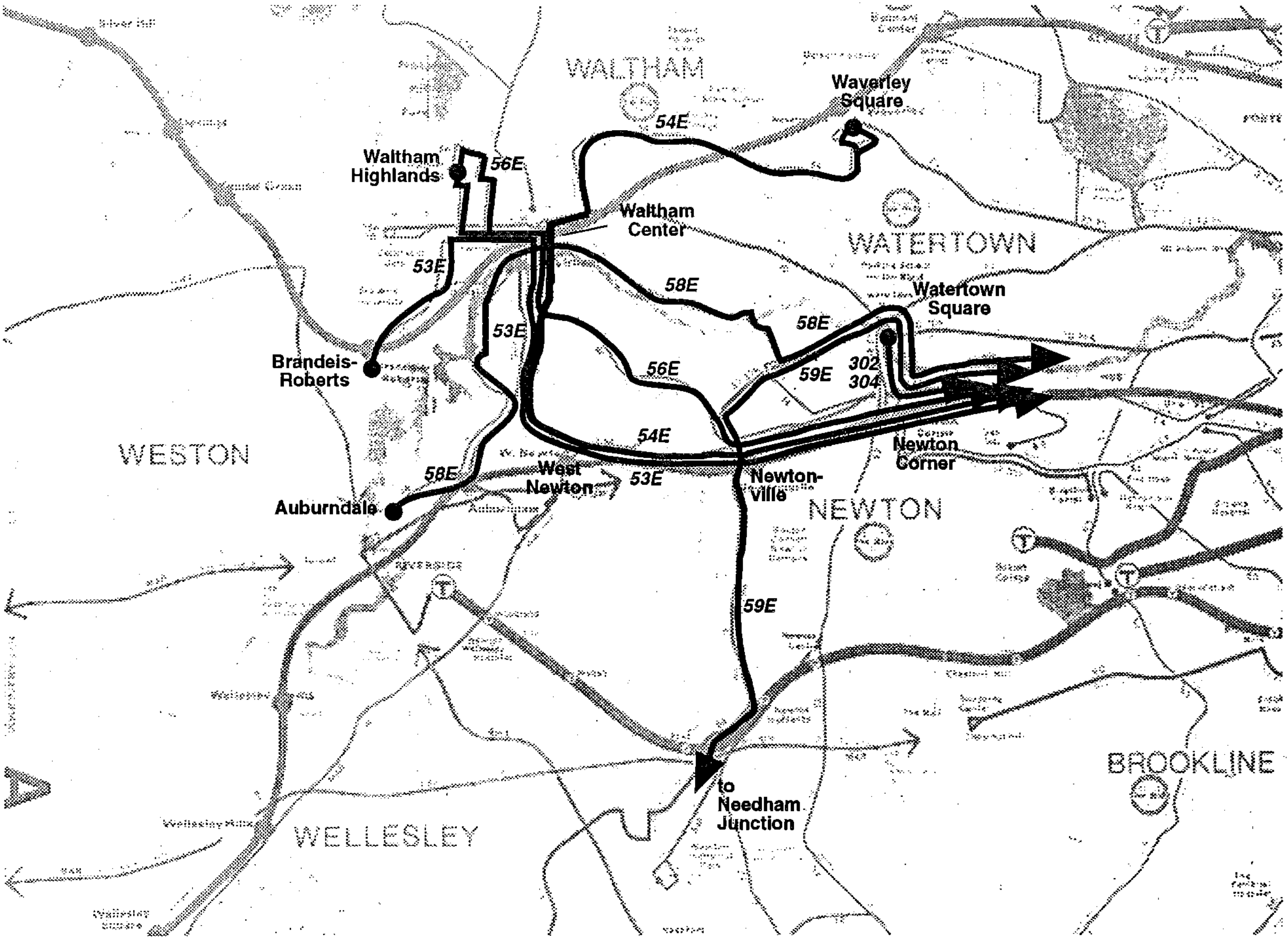
[9]Note that the parking costs do not include land acquisition. In some cases, multiple routes share a lot. For those lots, costs are split according to projected demand by route.

[10]For additional detail on these routes, see Appendix G.

Figure 9-9
Improved Express Service in the Mass Pike Corridor



- Route 53E: Brandeis/Roberts–Downtown Boston
- Route 54E: Waverley Square–Downtown Boston
- Route 56E: Waltham Highlands–Downtown Boston
- Route 58E: Auburndale–Downtown Boston.
- Route 59E: Needham Junction–Copley Square/Downtown Boston

Overall, the combination of local express routes in the Mass Pike corridor would represent a more efficient use of existing resources. In total, the combination of local and express routes in the Mass Pike corridor would attract 520 total trips and 320 new transit trips. While these increases are small, no capital costs would be involved, and the increase in fare revenue ($120,000 per year) would exceed the increase in operating costs ($83,000 per year).

In more detail, the impacts would be as follows:

Ridership
The combination of existing local and express routes in the Mass Pike corridor would attract 520 new trips and 320 new transit trips. While these increases are relatively low, they would represent increases on existing services that could be achieved without incurring any capital costs.

Costs and Cost-Effectiveness
The through-routing of Mass Pike express routes with Waltham and Newton local routes could be accomplished with the same number of buses as are now deployed on those routes. Therefore, no capital costs would be involved. For the most part, the same amount of service as is currently being provided would be reallocated. In total, there would be a slight increase in the number of vehicle service hours provided that would increase operating costs by $83,000 per year. The service improvements would generate $120,000 per year in new fare revenue, which would result in a farebox return of 145 percent.

Air Quality
The through-routing of Mass Pike express routes with Waltham and Newton local routes would provide only a very small reduction in regional emissions (less than 0.01 percent), but at no cost.

Better Downtown Boston Bus Distribution

Most existing express and local bus services from Boston neighborhoods and suburbs provide only limited distribution in downtown Boston. Service is operated in this manner so that buses avoid downtown traffic congestion that could adversely affect on-time performance. However, by avoiding much of downtown, the markets that are directly served are smaller, and ridership is presumably lower than it otherwise might be. (In contrast, many private-carrier bus services to and from downtown Boston do provide some sort of distribution in downtown areas.)

Existing congestion and the configuration of downtown streets provide only limited opportunities for providing better circulation within the downtown area. There are no ideal sets of streets; however, one loop on relatively free-flowing and/or auto restricted streets would be a counter-clockwise loop consisting of:

- Franklin/Bromfield Streets
- Tremont Street
- Boylston/Essex Streets

- High/Federal Streets

All routes operating into downtown could travel around all or a portion of this loop (see Figure 9-10)..

The reconfiguration of bus service in downtown Boston to provide better service coverage to the Financial District, Downtown Crossing, Government Center, Beacon Hill, and Chinatown would eliminate a transfer or a long walk for many existing and potential riders. The improved convenience that could be provided would attract a large number of new riders—11,900 total trips, and 7,200 new transit trips. This would be one of the largest ridership increases that could be achieved by any of the PMT alternatives. The large ridership increase would also translate into a relatively large reduction in regional emissions.

Further, the improved service could be provided at one of the lowest costs of any PMT projects. Including the purchase of new buses, the total cost would be $6.1 million. In terms of the number of new riders attracted and the air quality benefits, this cost is very low. The new services would generate as much in new fare revenue as they would cost to operate ($1.3 million per year).

The only potential negative to this alternative is the impact on traffic conditions on certain streets; these impacts are not known at this time. Overall, this alternative would remove much more traffic than would be added (the removal of up to 3,000 cars in the AM peak versus the addition of 150 buses). However, localized problems could be caused by the concentration of bus service on certain streets, and subsequent analysis would be needed to determine these impacts. However, if there are severe impacts in a specific area, there are other alignments that could be used that would provide similar benefits.

In more detail, impacts would be as follows:

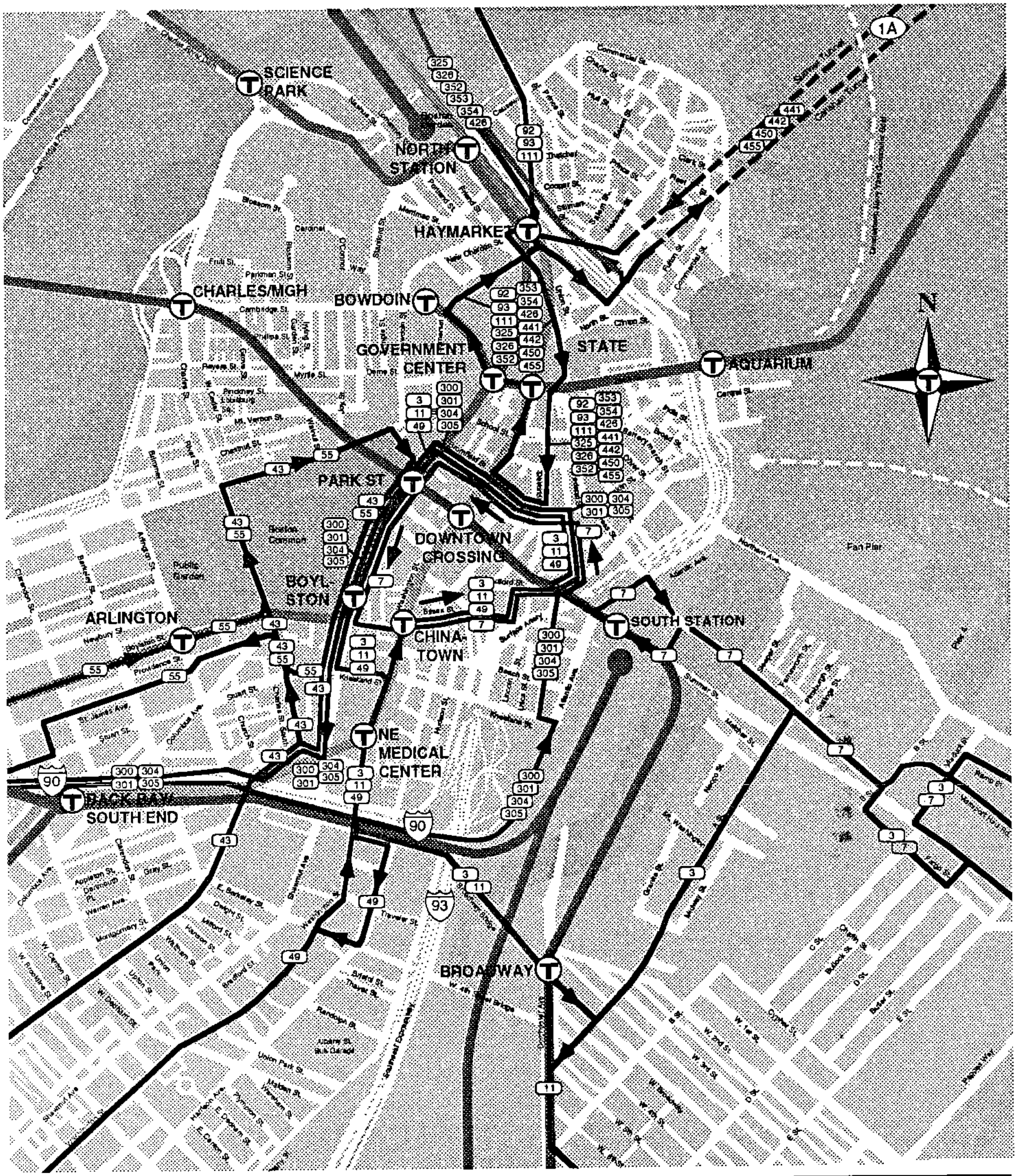
Ridership and Operational Impacts

The operation of all downtown Boston routes through more of downtown Boston would eliminate one transfer or a long walk for many potential riders. This increased convenience would attract up to 11,900 new trips to downtown Boston bus service per weekday. Of these, 7,200 would be new transit trips, and 4,900 would be diverted from other transit services (3,100 from rapid transit, and 1,800 from commuter rail). This would represent a 30 percent increase over current ridership levels. It would also be the third highest number of new transit trips that could generated by any of the PMT alternatives. The elimination of the transfer or long walk would also save a large amount of travel time for existing riders—1,730 hours per weekday, which would be the largest of any PMT project.

The PMT analysis was not detailed enough to break down the ridership on a route-by-route basis. However, the VMT savings figures indicate that the average length of trips diverted from automobiles would be over 11 miles. This implies that most of the new trips would be express trips. Further, the greatest increase in downtown service coverage would be for routes operating from the north, and it is believed that a large share of the increase would be on I-93 and North Shore routes.

As described above, the PMT analysis assumed that all peak period bus trips would run through downtown. During peak periods, this would mean changes to approximately 293 to 338 round trips:

Figure 9-10
Improved Circulation for Buses Operating to and from Downtown Boston



	AM Peak	PM Peak
Haymarket/Financial District Loop	150	133
Mass Pike/Financial District Loop	86	71
Financial District/Chinatown Loop	72	69
Park Square/Boston Common Loop	30	20
	338	293

Of these trips, the Haymarket/Financial District Loop bus trips would represent new trips in the downtown area. Trips on the Mass Pike/Financial District and the Financial District/Chinatown loops represent a rerouting of existing service, and not new trips. The Park Square/Boston Common Loop is a continuation of existing service and would not involve changes to service levels or the alignments of routes traveling that loop (Routes 43 and 55).

The most heavily utilized portions of the loops would be Franklin Street, High and Federal Streets, and Tremont Street. On Franklin Street, which would be a common segment of three of the four loops, bus traffic would increase from 110 trips in the AM peak to 308 trips. This would increase the number of bus trips 2.8-fold from an average of 0.7 trips per minute to 1.9 trips per minute. On other segments, there would be approximately one bus per minute (see Table 9-6).

Table 9-6
AM Peak Bus Volumes on Downtown Boston Streets

	Current		Future	
	Trips	Trips/Minute	Trips	Trips/Minute
High and Federal Streets	110	0.7	191	1.2
Franklin Street	110	0.7	308	1.9
Bromfield Street	0	0.0	158	1.0
Tremont Street	30	0.2	188	1.1
Essex Street	0	0.0	144	0.9

Costs and Cost-Effectiveness

To operate service through downtown most effectively, bus lanes would be placed on Lincoln, Summer, Federal, and Franklin Streets. This could be done through striping, and would not require a significant costs. Because of the high levels of service that would be operated on Franklin Street, some roadway modifications would be needed there. Bus shelters would be placed on Franklin Street between Otis Street and Province Street. The total cost of physical improvements would be approximately $100,000.

The greatest expense in providing better distribution would be the additional buses required. To operate all routes as described above would require 30 new buses at a cost of $6.0 million. This would bring the total cost of better distribution in downtown Boston to $6.1 million. If the MBTA has additional buses available, or if fewer routes were extended into downtown, the capital cost would be lower. However, at $6.1 million, this project would still be one of the lowest capital cost alternatives examined in the PMT. This, combined with high ridership increases, result in a capital cost per new weekday transit trip of only $850, which is also the lowest cost of any PMT project.

The additional service that would be required would increase operating costs by $1.3 million per year, but generate $1.3 million in new fare revenue. This is one of only a few PMT projects that would not increase the operating deficit.

Air Quality Impacts

The provision of better bus distribution in downtown Boston would reduce regional emissions by 0.09 percent. Better bus distribution in downtown would result in relatively large air quality benefits because a large proportion of the routes are express routes and would attract long trips. The 0.09 percent decrease in regional emissions that could be achieved if all of the downtown routes were extended would be exceeded only by the North Station - South Station Rail Link and Blue Line extensions that include the Red Line - Blue Line Connector. The capital cost per kilogram of VOC that would be eliminated each weekday would be $79,600. This would be by far the lowest cost for any project that would make a significant impact.

Long-Term Tier 1 Projects (after 2000)

Park and Ride Expansion (beyond SIP and CA/T Mitigation Requirements), and Intercept Stations along Major Highways

As discussed in the Short-Term section, the PMT analysis indicates that park and ride expansion would be one the most cost-effective ways to divert a significant number of automobile users to transit for the majority of their trip. By 2020, there will be demand for more spaces than will be added to meet SIP and CA/T Mitigation requirements; to meet this demand, parking expansion beyond that required for SIP and CA/T Mitigation purposes is recommended. Due to the nature and projected costs for some of the potential expansions, much of this expansion could not be implemented until after the year 2000.

Potential locations for parking expansion—both at existing lots and for new intercept stations—are the same as discussed in the "10,000 Parking Spaces by 12/31/96, and 10,000 Parking Spaces by 12/31/99" section of Chapter 8 (with additional details provided in Appendix G).

Rockport/Ipswich Commuter Rail/Blue Line Connection

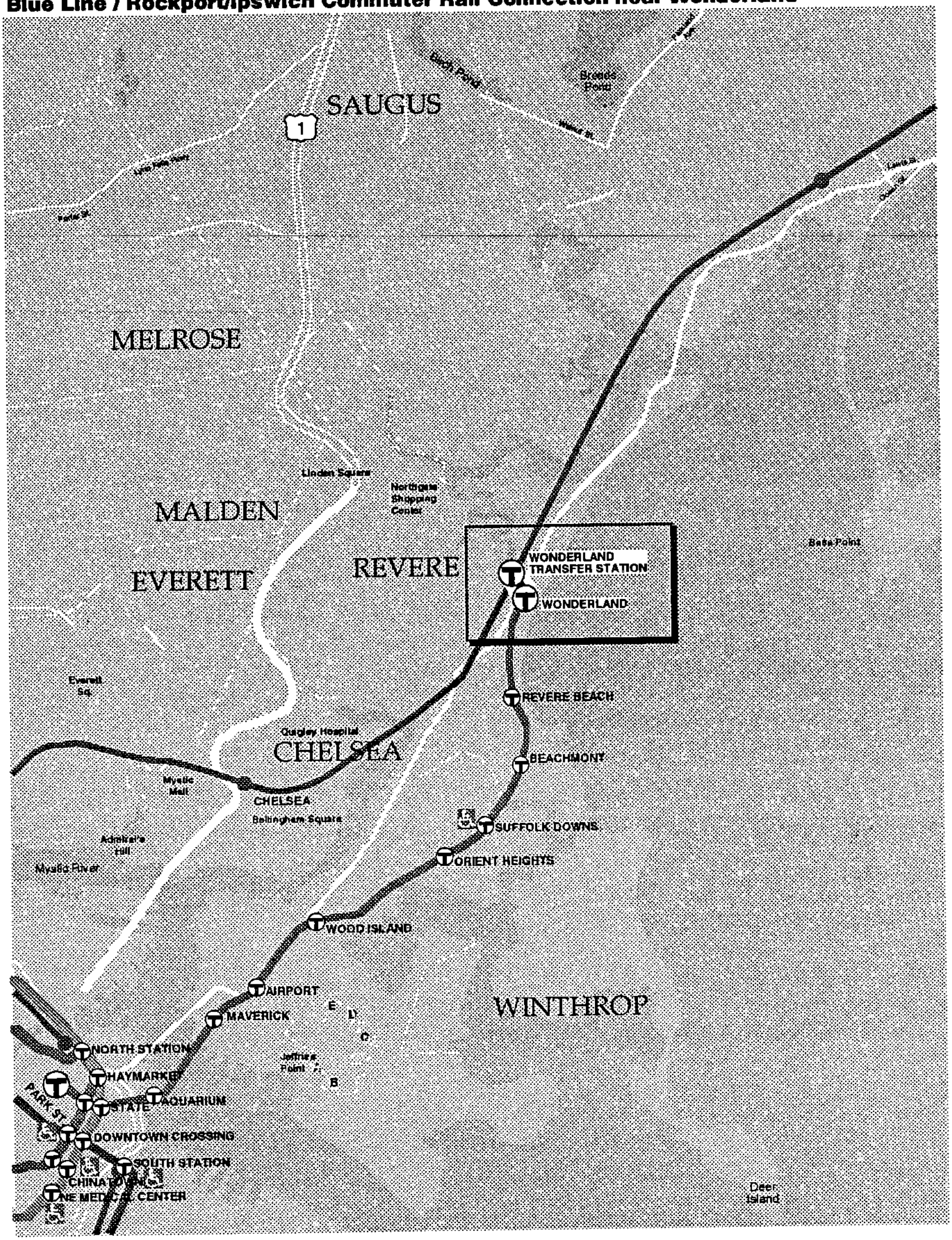
Commuter rail and rapid transit services operate in close proximity of each other, but without connections, in a number of locations throughout the region. In order to improve connections and expand travel possibilities, a number of connections were examined in the PMT. These were between:

1. the Fitchburg Line and the Red Line at Alewife.
2. the Rockport/Ipswich Line and the Blue Line near Wonderland.
3. the Framingham Line and the Green Line near Riverside
4. the Fairmount Line and the Red Line near Mattapan
3. the Old Colony Lines and the Red Line at JFK/UMass
4. more southside commuter rail trains and the Orange Line at Ruggles Station

Two of these connections—Rockport/Ipswich commuter rail with the Blue Line, and Fairmount commuter rail with the Red Line—would have merit under certain conditions. The former is included in Tier 1, while the latter is in Tier 2 because of its dependence on another Tier 2 project, the extension of the Red Line to Mattapan.

The Rockport/Ipswich commuter rail line has two branches: one to Rockport and one to Ipswich. Between North Station and Beverly Junction, the two branches use a common alignment that passes within 0.36 miles of the Blue Line terminal at Wonderland. The Rockport/Ipswich Line currently has connections to the Orange and Green lines at North Station, but no connections to the Blue Line. This connection could be created near Wonderland by extending the Blue Line 0.36 miles to the Rockport/Ipswich Line (see Figure 9-11). A new station would be built at this location. This connection would provide a faster service alternative to downtown Boston, as well as connections to Logan Airport. All commuter rail and Blue Line trains would stop at the transfer station.

Figure 9-11
Blue Line / Rockport/Ipswich Commuter Rail Connection near Wonderland



The Wonderland connection would be the best of any of the connections examined. It would serve a total of 7,200 trips per weekday, which would be higher than current ridership at a number of stations in the existing rapid transit system. The connection would be of the greatest benefit to existing riders who would be provided with faster and more convenient connections to downtown Boston and Logan Airport. Approximately 1,080 trips would be diverted from automobiles per weekday. The connection would cost approximately $9.3 million. In terms of the amount of new ridership attracted and the air quality benefits, this would be a cost-effective project.

As discussed above in the Blue Line extension to Lynn section, the MBTA has commissioned a study of a large number of new transit service options for the North Shore. This option would have the greatest merit if existing services continue to operate in a similar manner as they now do or with a Blue Line extension to Lynn. Therefore, a decision on whether to pursue this connections first depends upon the type of overall rail system that will be pursued on the North Shore.

In more detail, impacts would be as follows:

Ridership Impacts

A Wonderland connection between the Rockport/Ipswich Line and the Blue Line would have the largest volumes of any of the connections examined, and the new station would have higher total ridership (7,200 total trips per weekday) than many existing rapid transit stations. The connection would also generate 1,080 new trips.

A Wonderland connection would be used primarily for two purposes: (1) as a substitute for Orange and Green Line transfers at North Station, and (2) for trips to and from Logan. For riders who now use the Rockport/Ipswich Line to travel to and from downtown Boston, trips to the vicinity of State or Government Center stations could be made more quickly by making a transfer to the Blue Line at Wonderland rather than transferring to the Orange or Green Lines at North Station.

Costs and Cost-Effectiveness

The estimated capital cost of providing a rapid transit /commuter rail connection near Wonderland is $9.3 million. This cost includes extending Blue Line tracks 0.36 miles and constructing a new station. The $9.3 million would represent a cost of $8,600 per new transit trip. In this measure, a Wonderland connection would be one of the more cost-effective projects examined.

The extra distance from the present Wonderland terminal to the new transfer station, would increase Blue Line operating costs by $461,000 per year. A total of $247,000, or 54 percent of operating costs, in new fare revenue would be generated. (Increased commuter rail operating costs resulting from the transfer station were not estimated, but would likely be very low.)

Air Quality Impacts

Since the Wonderland connection would primarily provide better service to existing transit riders, it would have few air quality benefits, resulting in a reduction in regional emissions of 0.01 percent. The capital cost per kilogram of VOCs eliminated would be below average, at $980,000.

Inner Circumferential Transit

Boston has a large number of trip generators located beyond the central core. Many of these trip generators—UMass/Boston, Newmarket, the South End Medical Area, the Ruggles area, the Longwood Medical Area, Boston University, MIT, Kendall Square and Lechmere—ring the core. As these areas have grown, the demand for transit to, from, and between these areas has also grown. In response, a number of studies have been undertaken to examine the potential for new circumferential transit services. Most recently, the MBTA has undertaken a "Crosstown Transit Feasibility Study" to further examine bus options. In addition, the City of Boston is conducting its own "Crosstown Transit" study, and the Boston Society of Architects has recently begun to examine the concept of a "New Urban Ring."

The draft version of the MBTA's Crosstown Transit Feasibility Study will recommend the implementation of new bus routes to improve circumferential bus service in the short and mid term. The study indicates that such service would provide significant benefits for current riders and bring new riders onto the system, both by drawing people out of automobiles, and also by serving new economic development in the circumferential ring. The MBTA is now reviewing this study, but based upon the preliminary results, hopes to implement new bus ervice in the circumferential corridor during calendar year 1994.

The bus service would consist of new routes offering limited-stop service in two circumferential corridors, TSM improvements to reduce delays, and the development of improved bus stop facilities for circumferential service. (See Figure 9-12.) These bus routes would connect Cambridge, Boston University, the Longwood Medical Area, Ruggles, the South End Medical Area, and Andrew Square.

Running these new routes would require the purchase of nine new buses, entailing a capital cost of $1.8 million. In addition, roughly twenty-five passenger shelters/bus stations would be constructed, costing between $500,000 and $1,000,000 in total. The service would have a net operating cost of approximately $1.5 million annually, and carry approximately 7,500 daily riders.

Additional details on the new crosstown bus service will be available when the draft study is distributed in final form, which is expected in January or February, 1994.

To address longer-term improvements, the PMT analysis of inner circumferential transit included an examination of two light rail alternatives:

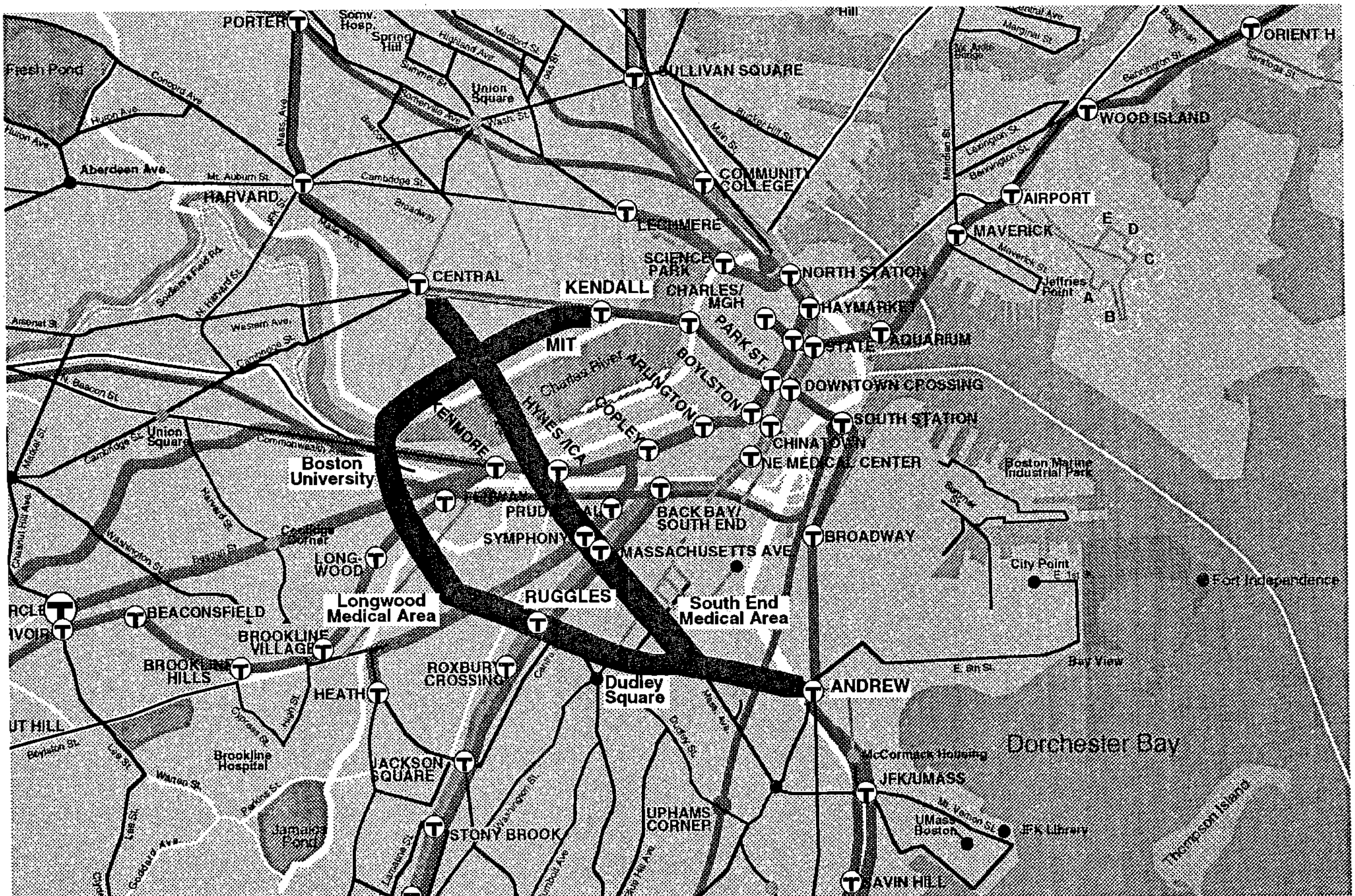
1. Sullivan Square – Ruggles ("Core LRT")

2. Logan Airport – JFK/UMass ("Full LRT")

The intent of using these specific alternatives was to test the concept of circumferential transit, rather than to select a specific mode or alignment. These alternatives are not intended to either endorse or preclude either alignment; subsequent analysis to examine other alignments and modes would be required before circumferential transit could be constructed.

The PMT ridership projections indicate that both circumferential LRT alternatives would attract a large number of new transit trips and make service more convenient for existing riders. The full alignment would serve a total of 149,530 trips per weekday of which 34,380 trips would be new transit trips. The core alignment would serve 86,700 total trips per weekday, of which 18,210 would be new transit trips. The 34,380 new trips for the full

Figure 9-12
Inner Circumferential Transit: Short-term Bus Service



alignment would be the largest number of new transit trips that would be attracted by any project examined in the PMT. The 18,210 new transit for the core segment would be the third largest number of new transit trips attracted.

Construction of a new circumferential LRT line would be expensive. Not including land acquisition costs, the full alignment would cost $1.4 billion, and the core alignment would cost $1.1 billion. These costs also assume that the Chelsea River crossing would be made via a bridge. A tunnel, which would likely be necessary to avoid conflicts with shipping, would increase costs further. Even without these additional costs, Inner Circumferential LRT would be the most expensive of all of the projects examined, except for the North Station - South Station Rail Link. Once constructed, either circumferential LRT alternative would have operating costs and revenues that would compare favorably with the existing system. The full alignment would generate a farebox return ratio of 45 percent; the core alignment 66 percent. (By comparison, farebox return ratios on existing rapid transit lines range from 27 to 35 percent.)

A circumferential line would have a significant positive impact on regional emissions: the full alignment would reduce regional emissions by 0.22 percent; the core alignment by 0.17 percent. These are the largest benefits that would be attainable by any single project examined in the PMT except the North Station - South Station Rail Link (which would reduce emissions by up to 0.54 percent).

Construction of a new circumferential LRT line would also have significant construction impacts, especially along the core alignment between Sullivan and Ruggles. Although the determination of traffics impacts during construction was beyond the scope of the PMT, it would be difficult to construct a circumferential line at the same time as the new Central Artery without significant impacts.

In summary, the PMT analysis has confirmed that there is a significant demand for improved circumferential transit services, but that costs would be high. As a result, examination of various alignments and types of services should continue.

Additional details on the two alternatives examined are as follows:

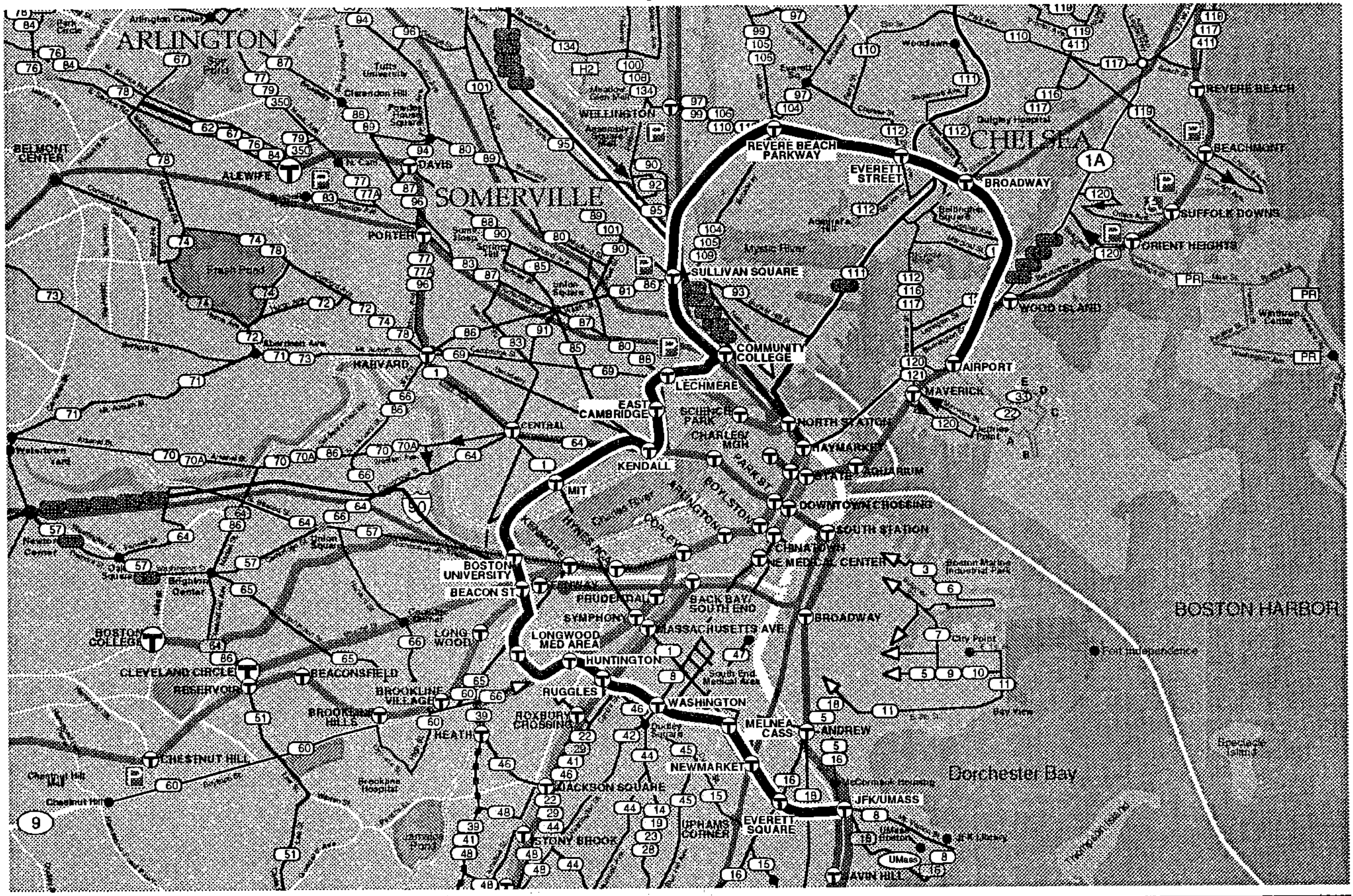
Description of Alternatives
Both LRT alternatives would use technology similar to the Green Line (but with low floor cars). For both alternatives, all trains would operate the full length of the line at four minute headways during peak periods, and at eight minute headways during off-peak periods.

Full LRT: Logan Airport - JFK/UMass The full alternative would operate 13.3 miles between Logan Airport and JFK/UMass Station through East Boston, Chelsea, Everett, Charlestown, Cambridge, the Fenway, Roxbury, and Dorchester. There would be a total of 20 stations providing local access and connections to all rapid transit and commuter rail lines. (See Figure 9-13)

From south to north, stations would be located as follows:

JFK/UMass, with connections to the Red Line.
Edward Everett Square, near the intersection of Boston Street and Columbia Road
Newmarket, at Mass Ave with connections to the Fairmount Line.
Melnea Cass, at the intersection of Melnea Cass Boulevard and Mass Ave.

Figure 9-13
Inner Circumferential Transit: Full LRT Alternative



Washington, at the intersection of Melnea Cass Boulevard and Washington Street near Dudley Square, and with connections with Washington Street replacement service.
Ruggles, with connections to the Orange Line, and with the Stoughton, Attleboro, Franklin, and Needham commuter rail lines.
Huntington, at the intersection of Huntington Ave and Ruggles Street, with connections to the E/Arborway branch of the Green Line.
Longwood Medical Area, on Longwood Avenue near Binney Street.
Beacon Street, on Park Drive near Beacon Street, with connections to the C/Cleveland Circle and D/Riverside branches of the Green Line, and the Framingham commuter rail line.
Boston University, at Commonwealth Ave near Saint Mary's Street, with connections with the B/Boston College branch of the Green Line.
MIT, at Mass Ave near Vassar Street.
Kendall, with connections to the Red Line.
East Cambridge, in the vicinity of the Galleria Mall.
Lechmere, with connections to the Green Line, and with limited parking.
Community College, with connections to the Orange Line and all northside commuter rail lines (Fitchburg, Lowell, Haverhill/Reading, and Rockport/Ipswich).
Sullivan, with connections to the Orange Line and with parking.
Revere Beach Parkway in Everett at the intersection of Revere Beach Parkway and Broadway, with parking.
Everett Street in Chelsea, with parking.
Broadway in Chelsea, with connections to the Rockport/Ipswich Line, and with parking.
Airport, with connections to Logan Airport and the Blue Line.

The core section of the alignment between Sullivan Square and Ruggles would be fully grade-separated and would operate in an exclusive right-of-way. The northern segment between Sullivan and Logan Airport would operate in railroad rights-of-way with some at grade crossings. The southern segment between Ruggles and JFK/UMass would operate in a combination of exclusive rights-of-way and in roadway medians (with a number of at-grade crossings).

Core LRT: Sullivan - Ruggles
This alternative would be a short variation of the full alternative that would operate only along the 7.3 mile Sullivan – Ruggles segment. The alignment would be identical to the Sullivan – Ruggles segment described above for the full alternative. (See Figure 9-14).

Ridership Impacts
Both LRT alternatives would carry high ridership: 149,530 total trips on the full alignment between Logan Airport and JFK/UMass, and 86,700 on the core segment between Sullivan and Ruggles. The full alignment would attract 34,380 new transit trips, and the core segment would attract 18,200 new transit trips. The 34,380 new trips attracted by the full alignment is the largest number of new trips that would be attracted by any project examined in the PMT. The 18,200 new transit trips attracted by the core segment would be the third largest number of new transit trips attracted.

Total ridership would be much higher on the core segment than on either of the two ends beyond Sullivan and Ruggles (see Table 9-7). Of the 62,830 additional trips that would be carried by the full alignment, 29,330 of the new boardings would be on the southern end between Ruggles and JFK/UMass, 12,550 would be at stations on the northern end between Sullivan and Logan Airport. The remainder would be new boardings attracted to core stations for trips to the outer ends.

Figure 9-14
Inner Circumferential Transit: Core LRT Alternative

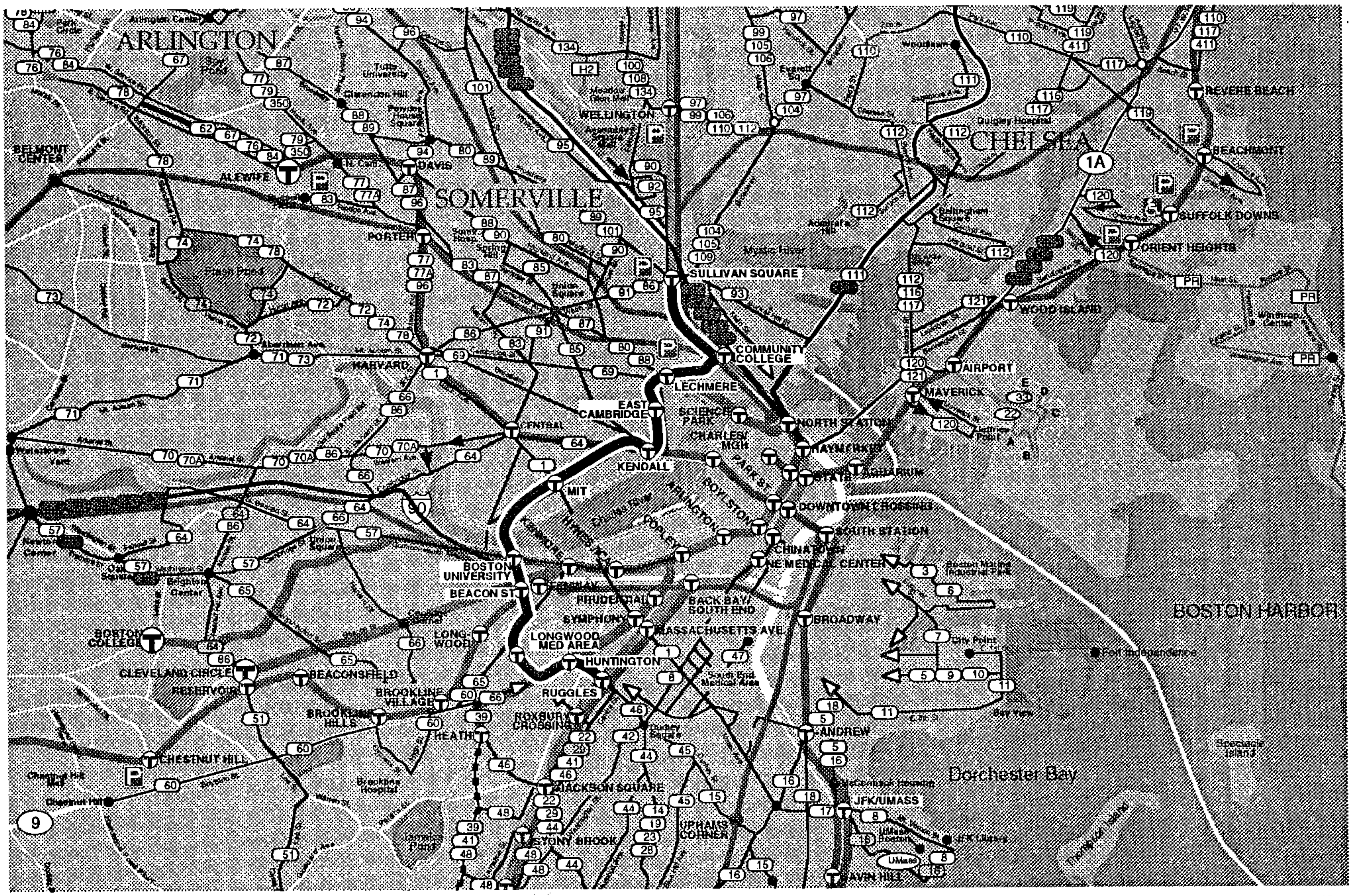


Table 9-7
Inner Circumferential Transit LRT Alternatives:
2020 Weekday Total Station Boardings

	Full LRT	Core LRT
JFK/UMass	9,380	—
Everett Square	2,190	—
Newmarket	5,580	—
Melnea Cass	8,600	—
Washington	3,580	—
Ruggles	19,150	12,840
Huntington	12,810	7,660
Longwood Medical Area	5,480	5,510
Beacon Street	14,910	12,180
Boston University	13,480	13,180
MIT	12,760	11,250
Kendall	13,150	11,590
East Cambridge	1,940	1,760
Lechmere	4,430	3,200
Community College	5,900	5,250
Sullivan	3,650	2,280
Revere Beach Parkway	650	—
Everett Street	2,260	—
Broadway	4,390	—
Airport	5,250	—
Total	149,530	86,700

Although total ridership would be much higher at core stations, nearly as many of the new transit trips would be attracted by the outer end services. This is because the core area is more intensely served by the existing system. As a result, while many existing trips could be made more conveniently with a circumferential LRT line, they can still be made relatively easily on existing rapid transit lines. The areas surrounding the outer ends however, are less well served by the existing system, and a circumferential LRT line would provide a greater improvement in service. In these areas, the markets are smaller, and therefore, total ridership would be lower, but a larger proportion of these trips would be new transit trips (26 percent versus 21 percent).

Impacts on Other Services

A circumferential LRT line would have a number of impacts on other MBTA services. In summary:

- Green Line ridership would decline by 25,250 trips per weekday. This decline would be due to diversions from the Green Line to the Circumferential Line. The Green Line Central Subway is approaching capacity; a circumferential LRT line would alleviate this problem to a certain degree.

- Red Line ridership would decrease by 6,890 trips per weekday, Blue Line ridership would decrease by 6,450 trips per weekday, and Orange Line ridership would decline by 16,750 trips per weekday. As with the Green Line, these declines would be due to diversions to the circumferential line.

- Commuter rail ridership would increase by 2,480 trips per weekday. This increase would occur primarily as a result of the connection between southside commuter rail lines and the circumferential line at Ruggles. This would greatly improve access from commuter rail to Cambridge, Boston University, and the Longwood Medical Area. The northside connection at Community College would be used for 2,800 trips per weekday, but only 360 of these would be new trips.

- Local bus ridership would decrease by 49,700 trips per weekday. These would be trips that would be diverted to the circumferential rail line from bus routes that would be replaced by the rail line.

Costs and Cost-Effectiveness

The construction of a circumferential rail line would be a major undertaking that would likely have significant construction impacts, including construction of a new subway along most of the core alignment, new stations, connections to existing lines, and various roadway changes in the vicinity of new stations. The costs used for the PMT analysis are based on estimates prepared for the MBTA, updated to 1993 dollars and using more recent data where available. Capital costs for the two alternatives, excluding land acquisition, would be $1.4 billion for the full alignment, and $1.1 billion for the core alignment. Note also that these costs assumed that the Chelsea Creek crossing would be made via a bridge. A tunnel would likely be necessary to avoid conflicts with shipping. The potential costs for land acquisition and a tunnel under Chelsea Creek could add significantly to the cost of the full LRT alternative.

Without making any allowance for the above cost factors, the capital cost per new weekday transit rider would be $41,630 for the full alignment, and $59,200 for the core alignment. The cost per new rider is lower for the full alignment because capital costs are significantly lower for the two outer ends where service was assumed to be at-grade and did not reflect the probable need for a Chelsea Creek tunnel. Both of these costs are relatively high.

The full LRT alignment would increase operating costs by $13.7 million per year, while the core alignment would result in a much lower increase of $4.9 million. The full alignment would generate $6.1 million, or 45 percent of its operating costs in new revenue. The core alignment would perform better, recovering 66 percent of its costs in new revenue.

Air Quality Impacts

Both of the LRT alternatives would have a relatively large positive benefit on regional emissions. The core alignment would reduce regional emission by 0.17 percent; the full alignment would increase the reduction to 0.22 percent. These are the second largest benefits that would be attainable by any single project.

The cost of these benefits would be high, at $7.6 to $7.8 million per kilogram of VOC eliminated per weekday. Of all projects that would have a significant impact, these costs among the highest, and would be exceeded only by a conversion of the Riverside branch of the Green Line to Blue Line service.

South Boston Piers Transitway: South Station to Boylston

Construction of a new transit line—the South Boston Piers Transitway—between South Station and the South Boston Piers area near the World Trade Center is planned to begin in 1994. Service should start in 1999. Transitway service will consist of electric dual mode buses operating in a tunnel with three stations: South Station, Fan Pier/Pier 4, and World Trade Center. Beyond the World Trade Center, Transitway vehicles would operate on

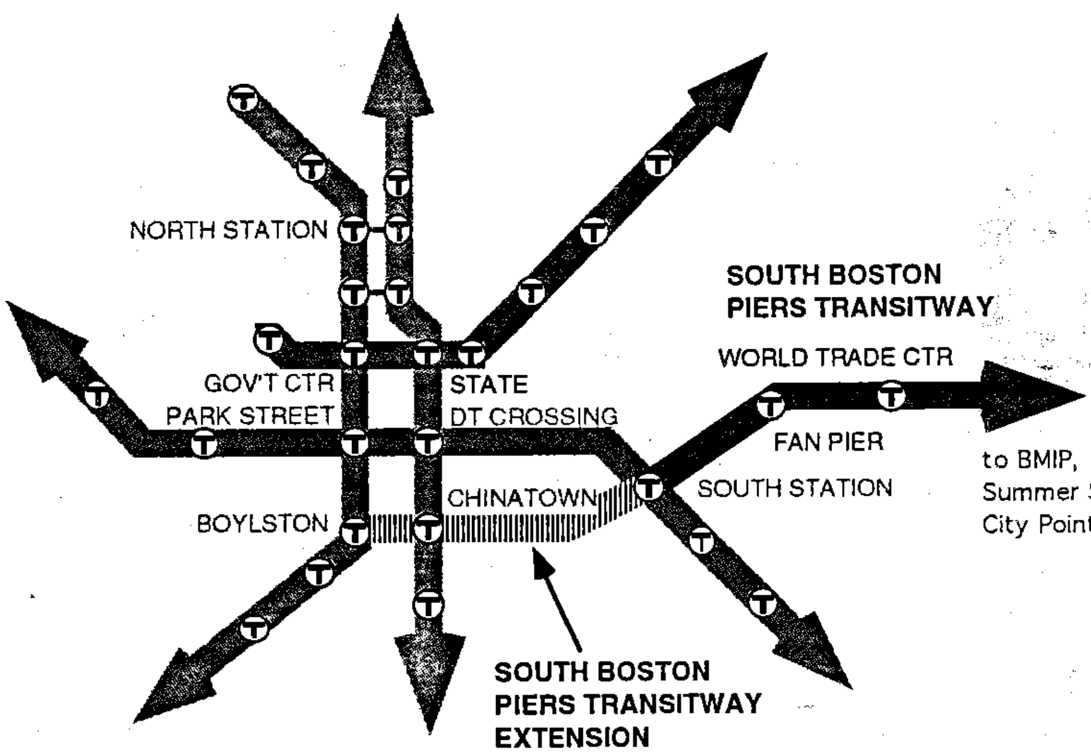
surface streets in the same manner as diesel buses. The PMT examined an extension of this planned service from South Station to Boylston Station, where connections could be made to the Green Line (and possibly with Washington Street replacement service).

The success of an extension will reflect the amount of growth that occurs in South Boston. With previously predicted high growth, the extension would be well utilized, with total ridership of up to 36,000 per day, including 7,800 new transit riders. The South Boston Transitway extension should be considered a high priority project capable of serving the current plans and projects going forward in the South Boston Piers area. Construction of this link should be timed to occur concurrent with that growth.

In more detail, this project and its impacts would be as follows:

Project Description
The alternative carried in the PMT analysis and studied in the DEIS/SDEIR extends the Transitway tunnel connecting the World Trade Center to South Station westward under the Central Artery parallel to Essex Street and finally to Tremont Street at Boylston. This extension of the Transitway would provide transfers to the Orange Line at Chinatown station and the Green Line at Boylston station (see Figure 9-15). A new platform and turnaround loop would be constructed one level below the existing Boylston Green Line platforms. A connection to Washington Street replacement service would also be possible at this location.

Figure 9-15
South Boston Piers Transitway Extension to Boylston



Three separate routes would use this Full Build tunnel. Two of the routes would be extensions of the routes contained in the Base Case project: 1) Boylston to BMIP and 2) Boylston to Summer Street. The third route, Boylston to City Point, would replace Route 7 running from Downtown to City Point via Summer Street. The first two routes would have peak period headways between 1.6 minutes and 2.6 minutes, while the third route would have a peak period headway ranging between 4.6 and 5.5 minutes.

The vehicles used for these Transitway routes would be high-capacity 60-foot articulated buses. They could be trackless trolleys, powered through electric trolley wires strung in the Transitway and along the streets on the surface, or dual-powered buses capable of operating with electric power through trolley wires inside the tunnel and with diesel power outside of the tunnel. The South Station to Boylston extension would require 20 more of these buses than would be required for the South Station to World Trade Center project.

In addition to the routes using the Transitway, the DEIS/SDEIR proposed several supplemental bus routes to improve access and connections to the South Boston Piers area. The most important of these are a shuttle bus from North Station to the Piers area via the Surface Artery and Northern Avenue and a new local bus route from the residential part of South Boston to South Station via D Street and Congress Street.

Ridership

The DEIS/SDEIR provides two sets of forecasts for 2020 ridership corresponding to two different projections of employment growth in the South Boston industrial area. For the "Lower Growth" scenario, the additional ridership on the Transitway due to the extension to Boylston totals 26,850 daily trips (13,425 in each direction). Of these trips, roughly 6,500 would be new transit riders, people who either used to drive or walk. The rest would be diverted from other transit services such as local buses and rapid transit lines.

The "High Growth" scenario forecasts 36,000 trips due to the extension (18,000 in each direction). Of these trips roughly 7,800 would be new transit riders with the rest coming from other transit services.

Costs and Cost-Effectiveness

The estimated capital cost for the extension of the South Boston Transitway to Boylston is $180 million. This includes the tunneling and station costs between Boylston and South Station and the vehicle costs for providing the extended service.

Operating costs for the Full Build project would be lower than those for the South Station to World Trade Center portion. The extension to Boylston allows for the elimination of several bus routes which would necessary for the World Trade Center to South Station service but not for the Full Build. The annual operating cost savings under the Lower growth scenario is $456,000 and for the High growth scenario, $1.6 million.

Fare revenue under the Lower growth scenario would increase by $280,000 with the extension to Boylston, but would drop by $40,000 under the High growth scenario. The changes in fare revenue have more to do with the supplementary bus routes than they do with the Transitway itself.

At the estimated demand level for the High growth scenario, the Transitway extension to Boylston would have a capital cost per new transit rider of $23,077. In this measure, it would be less expensive than all the rapid transit extension projects examined for the PMT. The annual cost per hour of travel time savings would be negative at -$4.05 because of the

net decrease in operating costs. The numbers for the Lower growth scenario are somewhat less favorable at $27,692 and $0.07 respectively.

Air Quality Impacts

Environmental benefits for the extension to Boylston would be in the mid-range of projects examined for the PMT. Regional emissions would be reduced by 0.05 percent for the High growth scenario. The capital cost per kilogram of weekday VOC eliminated would be $4,511,957. For Lower growth, these figures are 0.04 percent and $5,652,911 respectively. The High growth cost is less than the unit cost for most of the rapid transit extensions examined, but greater than those for most of the commuter rail extension or improvement projects.

North Station - South Station Rail Link

Currently, passenger railroad service into and out of Boston—both intercity and local—is provided by two physically isolated systems. One stretches in northerly directions from North Station at the northern edge of downtown Boston. The other serves areas to the south and west of Boston from South Station, located at downtown Boston's southern fringe. The two stations are separated by a distance of just over one mile.

Together, these two systems have eleven different rail routes serving 53 communities with a total of 101 stations. Five of the routes, with 52 outlying stations, terminate at North Station; six of the routes, with 46 outlying stations, terminate at South Station. Intercity service to New York, Washington, and Chicago now is confined to the southern system, but the northern system will also be used when Amtrak service is extended to Portland, Maine.

The "Central Artery Rail Link Task Force" examined the feasibility of connecting the northside and southside commuter rail systems by constructing a rail link along a similar alignment as the new Central Artery. The information in this section is from the Rail Link report,[11] and other supplemental information provided by the Task Force. (Additional study of North - South Rail Link alternatives is planned for this year by the Federal Transit Administration (FTA).)

The Central Artery Rail Link would be a two to four track tunnel that generally would be located below the new Central Artery (see Figure 9-16). To the south, there would be two portals, one along Herald Street east of Back Bay Station, and the other in the vicinity of the railroad yards south of the West Fourth Street Bridge in South Boston. To the north, there would be one portal near the Gilmore Bridge in Somerville.

The Rail Link would have three stations: South Station, North Station, and a new "Central Station" located near the Blue Line's Aquarium Station. New underground platforms would be constructed at North and South Stations.

The Task Force envisioned that the Rail Link and associated service improvements would be implemented in two phases:

- **Phase 1** would include construction of a two track Rail Link with four track stations, with implementation of through intercity service between New York and Portland, and of electrified regional rail service between Providence and Haverhill, and between Stoughton and Lowell.

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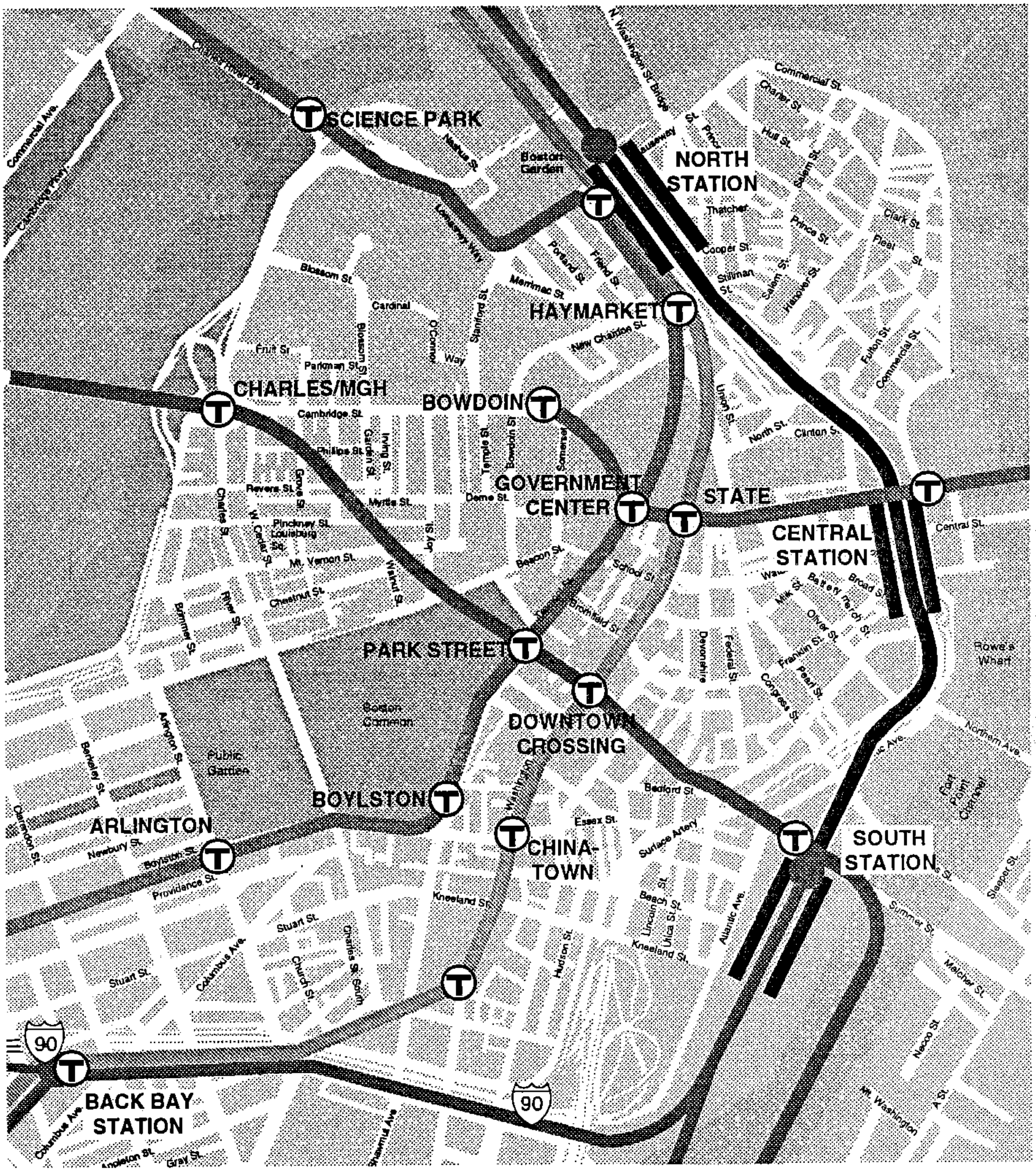
[11]"Building for an Intermodal Future: The North-South Rail Link," EOTC, May 1993.

Figure 9-16
Central Artery Rail Link



Source: Central Artery Rail Link Task Force

- **Phase 2** would involve expanding the Rail Link tunnel to four tracks and electrifying the remainder of the commuter rail system. Since only electrified service could operate through the Rail Link tunnel, this electrification would be necessary to provide the through-routing of northside and southside lines (as described in the next section).

Rail Link Service Concept

With the Rail Link, the existing commuter rail system could be upgraded from a predominantly commuter oriented service, with limited off-peak service, to an all-day service designed for a wider range of travel purposes and destinations. There would be three principal distinguishing service characteristics of a regional system with the Rail Link:

- Most local rail trips would run through the Rail Link. Inbound trips from the north would become outbound trips on the south side, and visa-versa. Northside and southside lines would be paired to facilitate regional travel.

- More frequent service would be provided. This would both strengthen peak service by providing riders with more flexibility, and make rail more attractive for non-commuter trips.

- The run-through design and frequent service would also facilitate transfers from one line to another. For many trips, this would help make service more competitive with travel by automobile.

- Additional downtown station options would become available. Northside passengers would be able to travel to South Station and Back Bay, and Southside passengers would be able to travel to North Station.

The pairing of northside and southside routes that would be operated through the rail link would be based on a number of considerations. The most important of these would include: regional travel patterns, ridership levels, running times, geography, train lengths, and route length. Also, because the Rail Link would require electrified service, the timing of the electrification of individual commuter rail lines would be a factor. Based on these considerations, through rail lines as shown in Figure 9-17 were assumed for the purposes of the Rail Link analysis[12]

Findings of the Task Force

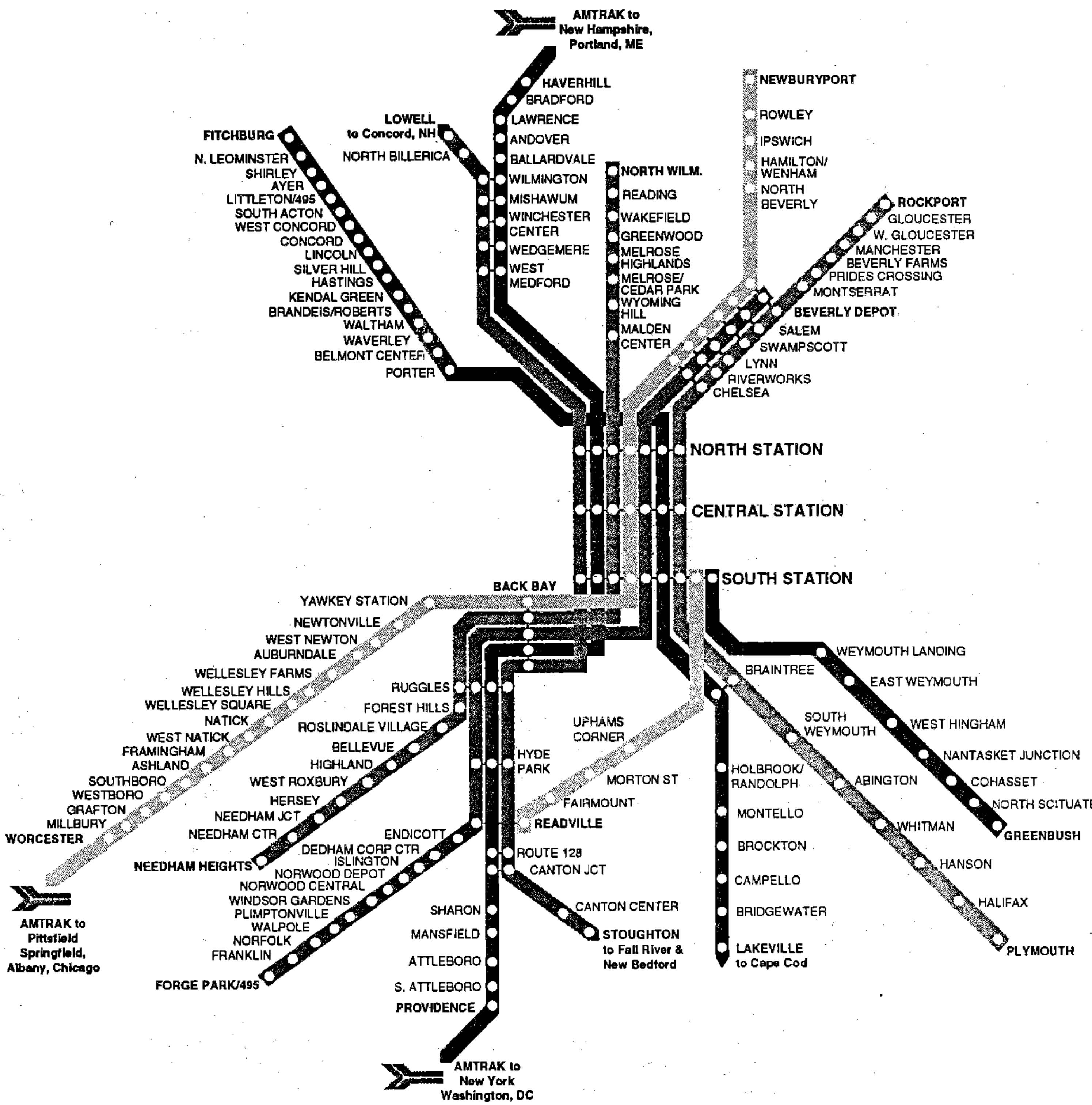
The findings of the Rail Link Task Force can be summarized as follows:

- **Feasibility**. It is feasible to build a two track Rail Link in the Central Artery Corridor with expansion capacity to a total of four tracks. The only changes that would be required to the CA/T project would be that deeper supplemental earth support walls would need to be included to permit subsequent construction of the Rail Link. This could be done without affecting the schedule of the CA/T project.

- **Alignment/Stations** The Task Force's preferred alignment would start from two southerly tunnel portals, one along Herald Street east of Back Bay Station, the other in

[12]Further study or operating experience may show the superiority of other potential rail pairings.

Figure 9-17
Regional Rail Network Schematic



Source: Massachusetts Bay Transportation Authority

the vicinity of the railroad yards south of the West Fourth Street Bridge in South Boston. North of South Station the Rail Link would be located directly beneath the depressed Central Artery, before moving off to the westerly side of the Artery alignment and passing under the Charles River to a northern tunnel portal near the Gilmore Bridge in Somerville. The Rail Link would have three stations, one under the existing South Station, the second near the MBTA Blue Line at State Street, and the third located between Haymarket and North Station.

- **Motive Power** Because of ventilation and safety requirements, all train operations through the Rail Link tunnel would need to be electrically powered.

- **Amtrak Service** The Rail Link would allow completion of the Northeast Corridor Amtrak intercity rail system with provision of through-routed service from Portland, Maine to Boston, New York, and Washington, D.C. This rail link would also allow for future provision of rail service to New Hampshire.

- **Regional Rail Service** The Rail Link would create a unified rail system for metropolitan Boston by combining the two currently separate northside and southside commuter railroad services. This would provide both improved core area trip distribution and regionwide service interconnectivity.

- **Regional Rail Ridership** With the Rail Link and faster electrified regional rail service, ridership would increase by 57,000 trips per weekday. Of the additional daily railroad trips, approximately 23,000 will be diverted from the highway system. Most of the remainder will be diverted rapid transit trips.

- **South Station Capacity** Construction of the Rail Link would eliminate projected South Station capacity problems. Old Colony service planned for 1996 and electric Metroliner service scheduled for 1998 will raise South Station track needs to sixteen—three above the thirteen that will be available when current track additions are completed. Additional commuter rail expansion would increase needs. Building the Rail Link would provide adequate railroad station capacity in downtown Boston into the indefinite future.

- **Construction Costs** Capital costs of $1.85 billion would be anticipated for Phase I of the Rail Link project. Of this total, $1.3 billion would be for construction of the Rail Link tunnel and stations, and installation of two tracks within the four-track tunnel. The other $550 million would be required for electrification of the lines to Haverhill, Lowell and Stoughton, and for the associated electric motive power. (The Providence line will be electrified as part of Amtrak's Northeast Corridor Project.)

  Phase 2 would cost an additional $1.78 billion. This would include $1.4 billion for electrification and locomotives for the remaining routes, and $417 million to complete four track installation within the tunnel.

- **Project Timing** Because of the time necessary for environmental analyses, project engineering, and resolution of institutional issues, it is not feasible to begin Rail Link construction in 1993 concurrent with that of the depressed Central Artery. Building Artery project slurry walls that extend down to the full depth necessary for both Artery and Rail Link construction, however, will make it possible for Rail Link construction to begin later than Artery construction.

In more detail, the impacts of a Rail Link would be as follows:

Ridership

With the Rail Link lines, and electrified service on all lines, commuter rail ridership would increase by up to 57,000 additional trips per weekday. Of these 57,000 rides, approximately 23,000 would be new transit trips diverted from automobiles. Most of the remaining 34,000 were trips made by travelers who had been using rapid transit.[13] At these ridership levels, the Rail Link would generate among the highest ridership increases of any PMT project.

Boardings and alightings at downtown stations would increase by 67,000 trips per weekday. By station, ridership would be as follows:

	Total Trips	Increase
North Station	33,000	4,000
Central Station	30,000	30,000
South Station	82,000	28,000
Back Bay	24,000	5,000

Because many riders could travel to a point near their final destination, many of the commuter rail/rapid transit transfers that now take place would no longer be necessary. The largest drop in transfers would be with the Orange Line at North Station. At the same time, the Rail Link will also result in new commuter rail to rapid transit transfers. New direct transfers to the Red and Blue Lines would be available to northside riders, and new direct connections to the Green and Blue Lines would be available to southside riders. A large number of new transfers would also expected to and from the South Boston Piers Transitway: 25,200 with the Rail Link versus 11,900 without the Rail Link.

Costs and Cost-Effectiveness

The regional rail service concept structured around the Rail Link would be implemented in two phases. Phase 1 would include completion of a two track Rail Link, with implementation of through intercity service between New York and Portland, and of electrified regional rail service between Providence and Haverhill, and between Stoughton and Lowell. Phase 1 is anticipated to have a total cost of $1.85 billion. Of this total, $1.3 billion would be for the Rail Link and stations and the remaining $550 million would be for electrification and electric locomotives.

Phase 2 would involve expanding the Rail Link tunnel to four tracks and electrifying the remainder of the commuter rail system. This would be necessary to provide the through-routing of all of the northside and southside lines described above. Phase 2 would cost an additional $1.78 billion. Of the Phase 2 expenditures, the greatest portion will be invested in electrification and locomotives ($1.4 billion). The expansion of the Rail Link to four tracks would cost approximately $417 million.

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[13] It should be noted that intercity passengers using Amtrak trains are not included in these figures. Amtrak ridership forecasts are being prepared by the Federal Transit Administration in support of the Rail Link planning effort. Amtrak ridership is concentrated at South Station, and current planning assumes that South Station and Back Bay Station will continue as the Amtrak stations in Boston. While Amtrak ridership is small in relation to regional rail, the percent increase in Amtrak patronage resulting from the Rail Link is expected to be significant.

The total capital cost of the two phases would be $3.63 billion. This cost makes the Rail Link the single most expensive project examined in the PMT. However, because of the inter-regional significance of the Rail Link (in terms of Amtrak service), it is possible that special federal funding could be available for the Rail Link that would not be available for other transit projects.

The $3.6 billion total capital cost translates to $64,000 of capital investment per new regional rail trip and $158,000 per new transit trip. Of the PMT projects that would significantly increase ridership, these capital costs per new rider for the Rail Link are the highest. (As mentioned before, these figures do not include new Amtrak riders attracted to through-routed intercity service.)

The Rail Link would make commuter rail operations more efficient by eliminating downtown layovers. This, together with the reduced travel times of electrified operations, would mean that more service could be provided with a given amount of equipment and crew. Including the impact of these efficiencies, the additional service that would be provided with the Rail Link would increase annual operating costs by $47 million.

The new trips attracted by the Rail Link and the improved service that would be operated would increase annual revenue by $36 million. This would represent a farebox ratio of 77 percent, which would be very high for a project of this magnitude.

Air Quality Benefits

The Rail Link would provide the greatest improvement in air quality of any of the PMT projects. With both Phase 1 and Phase 2 improvements, the additional trips attracted to commuter rail would reduce regional VMT by 366,000 miles per weekday. This would result in a 0.54 percent reduction in regional emissions.[14] Most PMT projects would reduce regional emissions by less than 0.10 percent.

However, because the cost of the full project is high, the cost of achieving the air quality benefits would also be high, at $8.1 million per kilogram of VOC eliminated per weekday.

Conclusions

The Central Artery Rail Link would provide a number of new transportation options to the residents and travelers in eastern Massachusetts and the Northeast by providing better connections combined with a higher level of rail service. It would divert 23,000 trips per weekday from automobiles to MBTA commuter rail services. This is the second highest number of auto-to-transit diversions for any individual project included in the PMT.

The Rail Link would provide a significant reduction in regional emissions, of 0.54 percent. This is the highest of any project, and three times that of a full inner circumferential LRT line, which would provide the second greatest improvement.

While the ridership and air quality benefits would be high, costs would be very high. The cost to construct the Rail Link and to electrify the existing system would be approximately $3.6 billion. This represents a cost of $158,000 per new transit trip, and $8.1 million per kilogram of VOC per weekday. The $158,000 capital cost per new transit trip is the highest

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[14]This reduction is due only to the diversion of automobile trips to commuter rail. There would be additional air quality benefits due the use of electric locomotives instead of diesel locomotives.

of any PMT project that could generate significant new ridership, and the $8.1 million cost per kilogram of VOC eliminated is the third highest.

Because of the high cost of the project, funding would be a major issue—both in terms of availability and the possible impact on other projects. However, due to the inter-regional significance of the Rail Link and the opportunities for expanded Amtrak service, it is possible that special federal funding may be available for this project that would not be available for competing projects.

Based on the findings of the Rail Link Task Force, it is clear that the Rail Link would provide a number of benefits to the region and the Northeast. Additional information on a Rail Link should soon be available following the completion of the FTA's study. In the short-term, based on the potential benefits of the Rail Link, the new Central Artery should be designed with provisions for the supplemental excavation support walls that would allow future construction of the Rail Link in the Central Artery alignment. A decision on whether to construct the Central Artery Rail Link should be deferred until after funding issues have been addressed and the FTA study has been completed. Further study to resolve outstanding issues is recommended.

Needham Commuter Rail Improvements/New Stations

The PMT analysis examined a possible replacement of Needham Line commuter rail service with an Orange Line extension. Based on that analysis, the examination of upgrading the Needham Line to provide a higher level of service with new stations at VFW Parkway and Route 128 is recommended.

The Orange Line extension to Route 128 in Needham, which would replace Needham Line commuter rail service, could attract a large number of new weekday transit riders (4,700), but be expensive, with a capital cost of $249 million. The new ridership would be attracted by the additional service that would be provided at existing stations, and by the construction of new stations at VFW Parkway and Route 128. It is likely that much of the ridership increase that would be attracted by an Orange Line extension could also be attracted constructing new stations and operating more frequent service on the existing commuter rail line. As a result, it is recommended that the examination of this type of upgrading be pursued, rather than conversion of the line to rapid transit.

Green Line Improvements

The PMT analysis examined three alternatives for extending the Blue Line to Riverside. One of the major benefits of such an extension would be that it would alleviate both passenger and vehicle crowding on the Green Line, which would improve reliability. However, the PMT analysis of the Blue Line alternatives indicated that a Blue Line extensions to Riverside would produce only moderate gains in ridership at a very high cost ($900 million to $1 billion). Largely on this basis, a Blue Line extension to Riverside was not included in the recommended program.[15]

However, Green Line crowding problems still need to be resolved. Therefore, a study of Green Line operations is recommended in lieu of further consideration of a Blue Line extension to Riverside. This study should be directed toward identifying modifications that

[15]For additional information on the costs and impacts of a Blue Line extension to Riverside, see Appendix G.

would improve operations and expand Green Line capacity. Potential improvements would include operating longer trains at slightly longer headways, straightening curves and eliminating speed restrictions on surface lines, eliminating train conflicts, adding tracks and platforms in high ridership stations (such as Park Street and Government Center), upgrading the signal system, and utilizing traffic signal pre-emption on surface branches.

Long-Term Tier 2 Projects (after 2000)

Blue Line Extension to Lynn

The Blue Line currently runs from Wonderland Station in Revere to Bowdoin Station in the Government Center area of downtown Boston. At six miles, it is the shortest of the MBTA's three high-platform rapid transit lines. The Blue Line has direct connections with the Orange and Green Lines, but not with the Red Line. Headways are currently 3.5 minutes during the peak period.

An extension of this line to Lynn would consist of a four-mile extension from Wonderland to Central Square in Lynn, via the Narrow Gauge right-of-way (see Figure 9-18). Intermediate stations would be located at Point of Pines, serving a residential community in northern Revere, and at West Lynn, serving the General Electric Plant and other employment.

Note that past studies of a Blue Line extension to Lynn have focused on a different routing. This alternative alignment would join the commuter rail right of way just north of Wonderland and run immediately adjacent to the existing tracks. Such a scheme would require widening the existing rail right-of-way through the marshes, necessitating significant destruction of wetlands. For this reason, the Narrow Gauge route was chosen for study in this PMT analysis. A consultant study of several North Shore transit improvements is considering both possible alignments. Ridership figures for the two alignments should not be very different, since the only difference in service between the two alignments is the station at Point of Pines.

A Blue Line extension to Lynn would have merit in a number of respects. The Blue Line extension could be an economic boon for Lynn, and it would provide a higher level of service for commuters to the urban core. These improvements in service come at a high cost, however. By most measures, the Blue Line extension be more costly, and less cost-effective than other rail extension included in the Additional Expansion category.

Also, the MBTA has recently commissioned a consultant study of several other options for improved North Shore transit, including conversion of the Rockport and Ipswich lines to electrified light rail or rapid transit, enhanced commuter rail service, and enhanced express bus service. Pending the results of that study, a Blue Line extension to Lynn is recommended as a Long-Term Tier 2 project, but the consideration of a different type of service may be appropriate pending the outcome of the North Shore Transit Study.

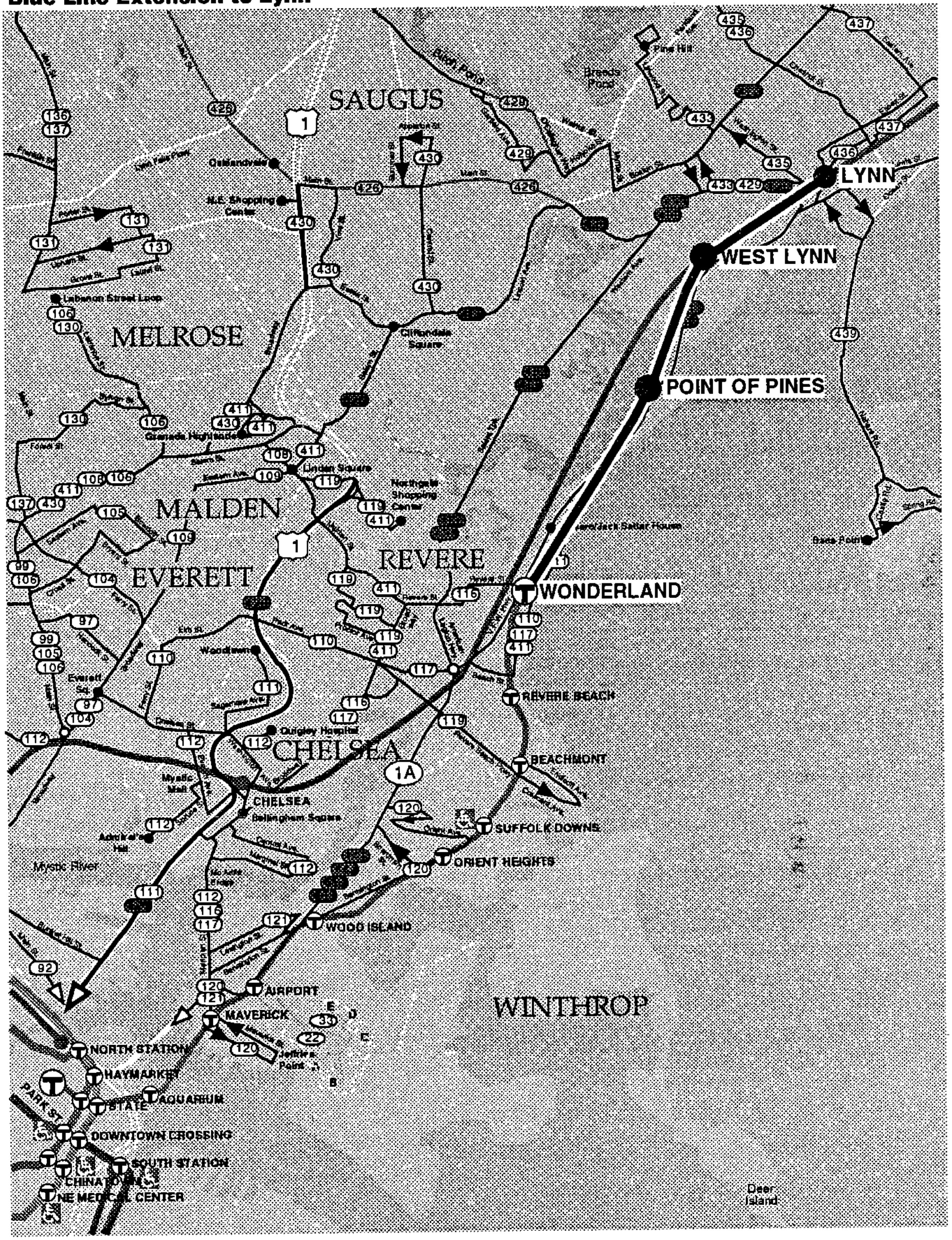
In more detail, the impacts of a Blue Line extension to Lynn would be as follows:

Ridership Impacts

The Blue Line extension to Lynn would serve 11,340 new weekday riders, of which 4,860 would be new users of the transit system. The rest would be diverted from commuter rail and express buses. The number of new trips attracted would be relatively high compared to other PMT projects. On a station-by-station basis, weekday ridership would be as follows:

Central Square Lynn:	7,140
West Lynn:	4,120
Point of Pines:	80
Total	11,340

Figure 9-18
Blue Line Extension to Lynn



At these ridership levels, the Central Square and West Lynn stations would have higher ridership than current ridership at all existing Blue Line station except Wonderland. However, ridership would be lower than current ridership at most Red and Orange Lines.

Travel time savings for existing transit riders would be 893 hours per weekday or 273,258 per year. These figures are relatively low among the rapid transit extensions, because the Blue Line would offer only a moderate travel time advantage versus commuter rail. (The trip from Lynn to Downtown Boston on the commuter rail currently takes 26 minutes, while the Blue Line trip would take roughly 30 minutes; the Blue Line stops 12 times before it reaches Government Center, while the commuter rail stops only once or twice before it reaches North Station. However, the higher frequency service of the Blue Line means that there is less out-of-vehicle waiting time, thus leading to the overall time savings.) The Blue Line extension would also provide better distribution in Downtown Boston than commuter rail or express bus, as well as direct transit service to Logan Airport. For riders making this type of trip, travel time savings would be greater.

Costs and Cost-Effectiveness

The construction cost of the Blue Line to Lynn would be in the mid-range of PMT projects examined to date. The approximate capital cost would be $275 million for track and power, three stations, a new bridge over the Pines River and 100 Blue Line vehicles. The capital cost per new transit rider would be highest compared to other rapid transit and commuter rail extension included in the SIP and CA/T Mitigation and Additional Expansion categories, at $56,600.

The operating cost would be among the highest of all the PMT projects, at $10.3 million annually. Fare revenue from the extension would be $1.4 million annually (assuming that stations beyond Wonderland would pay the same fare as Red Line riders from Quincy—double fare in, single fare out), resulting in a farebox ratio of only 14 percent. The operating subsidy per passenger would also be fairly high at $2.54.

Air Quality Impacts

The Blue Line extension to Lynn would reduce regional emissions by 0.07 percent, which would be a moderate reduction. The cost of the air quality improvements would be among the more expensive to attain of all PMT projects. The capital cost per weekday kilogram of VOC eliminated would be $4.6 million. This is more expensive than any of the commuter rail extensions and the other rapid transit extensions included in the recommended program.

Red Line Extension to Mattapan

A Red Line extension to Mattapan would replace the current Mattapan High Speed Line, which runs approximately 2.6 miles from Ashmont station at the end of one branch of the Red Line to Mattapan Square at Blue Hill Avenue. There are six station stops between Ashmont and Mattapan serving residential neighborhoods in South Dorchester and Milton.

At present, a trolley car runs every 4 minutes during peak periods, every 8 minutes during the day and every 12 minutes at night. The fleet for the High Speed Trolley is made up of President's Conference Committee (PCC) cars built in the 1940s. These are used because maintenance of the electronic systems of modern Light Rail Vehicles would require an on-line carhouse. It will not be possible to operate the High Speed Line indefinitely with the present

cars, and a decision on their replacement will be needed in the near future. Present peak schedules require six cars, all operated as single units.

The Red Line extension would operate along the same right-of-way as the Mattapan line, but with fewer stations. New rapid transit stations would be located only at Mattapan, Central Avenue, and Butler Street (see Figure 9-19). Present stations at Capen Street, Valley Road, Milton, and Cedar Grove would be discontinued. [16]

All Ashmont branch Red Line trains would run through to Mattapan instead of originating or terminating at Ashmont. Frequency would decrease on the Mattapan Line from 4 minute headways to 8 minute headways during the peak, but seating capacity would increase significantly because Red Line trains of four or six cars would replace the single unit PCC cars.

With the reduction in stops and the faster acceleration of the Red Line vehicles, travel time between Mattapan and Ashmont would be reduced from 9 minutes to 5 minutes. Passengers who currently transfer to the Red Line at Ashmont would have the additional convenience and time savings of a transfer-free trip. These time savings would be partly offset by the additional walking time imposed on those passengers whose current station would be closed.

A Red Line extension from Ashmont to Mattapan would attract fewer new riders than most of the other PMT projects examined to date. It would also be among the less expensive rail extension projects, with a capital cost of $54.8 million. Passengers from Mattapan, South Dorchester and Milton would receive somewhat less frequent service than is now provided by the High Speed Trolley line, but they would in almost all cases receive faster service and would be relieved of a transfer.

However, some of the capital improvements required for a Red Line extension to Mattapan would have to be implemented whether or not the Red Line is extended. For example, LRVs require a power system upgrade over the PCCs. In addition, the Americans with Disabilities Act requires that key stations on the Mattapan line be accessible to people in wheelchairs no later than 2020. The high platforms needed for a Red Line extension would solve the accessibility problem, while some other solution would be necessary if LRVs were used.[17]

It is also important to note that the Red Line extension was examined by the MBTA in 1968, but was withdrawn because of opposition from the town of Milton, which would have lost all of its station stops. It is unclear whether local residents would be in favor of the extension today.

The poor condition of the High Speed Trolley stations and vehicles means that the MBTA will have to make a significant investment in this facility in the next five to ten years. At that time, it would be prudent to consider the Red Line extension as one of the options, given its benefits from an operational and systems standpoint.

In more detail, impacts of this project would be as follows:

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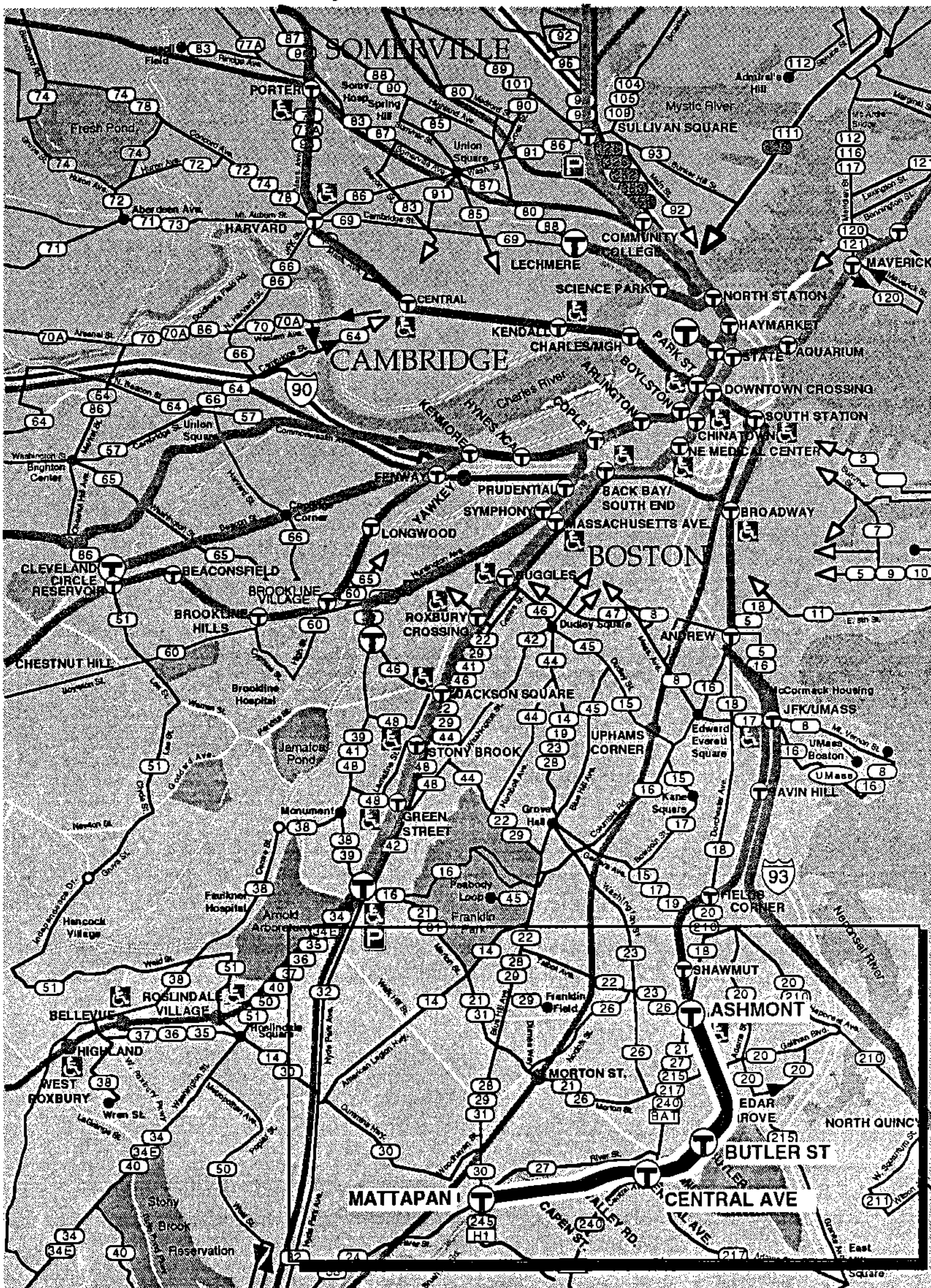
[16]CTPS counts in 1989 found that of 3,465 inbound daily riders on the High Speed Line, 548 or 15.8 percent used the stations that would be discontinued.

[17]One plan is to shift the Boeing LRVs from the Green Line to the Mattapan Line as the new low-floor cars are purchased for the Green Line. Accessibility would be achieved through the construction of mini-high platforms in conjunction with adjustments to the entryways of the vehicles to allow for level access.

Figure 9-19
Red Line Extension to Mattapan



Ridership
An extension to Mattapan would increase Red Line ridership by 4,720 trips per day in the year 2020. Of these, 1,260 would be new transit trips, and 3,460 would be diversions from other transit services. The largest share of transit diversions to the extension would come from the High Speed Trolley, which would be discontinued if the extension were built. Some of the remainder would come from MBTA local bus routes; MBTA Route 27 parallels the High Speed Trolley between Mattapan and Ashmont.

The projection of 1,260 new weekday transit trips for the Mattapan Red Line extension is the lowest among all of the rapid transit extensions being studied in the PMT, although it compares favorably to the commuter rail extensions and new express bus routes. Travel time savings for transit riders is estimated to be 338 hours per weekday, which is again the lowest of all of the rapid transit projects in the PMT.

Costs and Cost-Effectiveness
Among the changes needed for rapid transit conversion would be installation of signal and power distribution systems, elimination of grade crossings at Capen Street and Central Avenue, and construction of high level platforms at stations being retained. Red Line cars could run on the existing tracks.

The most recent capital cost estimate for these improvements and the additional Red Line cars needed to serve the extension is $54.8 million. The average capital cost per new weekday Red Line rider would be $11,600. The average capital cost per new weekday transit rider would be $43,500. Both costs are fairly low for rapid transit projects.

The fact that the PCC cars are nearing the end of their useful life means that the MBTA will have to undertake some improvements to this line in order to maintain service. In order to accommodate LRVs, the power system would have to be upgraded and some arrangements would have to be made for routine maintenance. Costs for such improvements have not been estimated yet, but it is clear that a portion of the money which would be spent for a Red Line extension would have to be spent anyway just to maintain the current service.

The Red Line extension to Mattapan would result in an increase of $1.3 million per year in operating costs, compared to an increase of $0.2 million in average weekday revenue.

Operational Impacts
Operationally, an extension to Mattapan would have limited impact on the Red Line. The number of trains passing over the existing line would be unchanged. Increased loads would result in slightly longer dwell times, causing increased running times. Since the number of new transit riders is relatively small, compared to other rapid transit extensions, the extension to Mattapan should not lead to serious crowding problems on the Red Line. Currently the branch is served by a mixture of four and six-car trains during peak periods. In the future, peak period service will consist of all six-car trains. There should be enough capacity available to accommodate the additional ridership.

The elimination of the High Speed Trolley would be a benefit from an operational standpoint. The current configuration is awkward from a systems perspective: it is better to have one integrated line than two separate ones.

Air Quality Impacts
A Red Line extension to Mattapan is projected to reduce regional emissions by 0.01 percent. This is among the lowest reduction among all of the rapid transit and commuter

rail extensions being studied in the PMT. The capital cost per kilogram of VOC eliminated per weekday would be $5,141,700.

Commuter Rail Service to New Bedford and Fall River

The PMT analysis for this project was based mainly on the results of a feasibility study of potential rail extensions beyond Stoughton completed for the MBTA by a consortium of consulting firms in 1990. Five alternatives were analyzed in that study. For purposes of comparison with other projects, the PMT used the fourth of these alternatives, which would involve the greatest amount of new service (see Figure 9-20).

This line would start at the present end of the Stoughton Branch and extend to Whittenton Junction in Taunton via an abandoned right of way owned by the MBTA. From there, it would continue to New Bedford via the New Bedford Branch and New Bedford Secondary Track (now used for freight service). A second extension would diverge from this one at Myricks in the town of Lakeville, and run to Fall River via the Fall River Secondary Track (also now used for freight service). Stations on the New Bedford route would be located on the Stoughton/Easton town line, at the Raynham Dog Track, in downtown Taunton, at East Taunton, and in downtown New Bedford. Stations on the branch to Fall River would be located in Freetown and in downtown Fall River.

Because of running time considerations, it was assumed that peak service on the New Bedford and Fall River line would be in addition to existing Stoughton service, and would not stop at any of the present stations between Easton and downtown Boston. Off peak-service would be run as extensions of existing Stoughton trains.

For the PMT analysis, capital costs in the 1990 study were updated for consistency with other PMT projects. The ridership projections in the study were prepared by CTPS, and are therefore consistent with other PMT estimates.

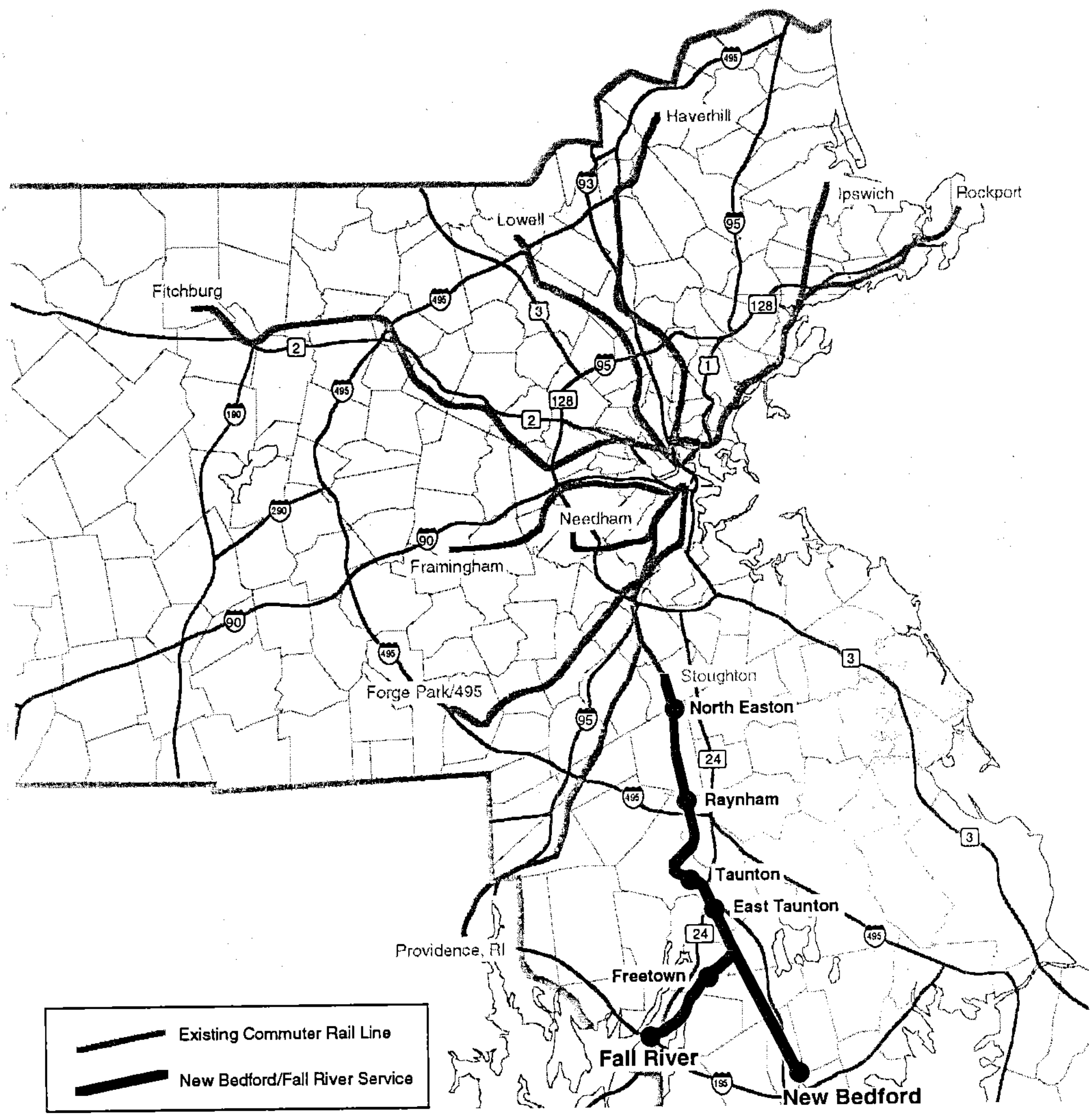
The new service to New Bedford and Fall River would serve an estimated 6,465 riders a day in 2020, including 2,820 new transit riders. This is the largest number of total trips and the second-largest number of new transit trips of any commuter rail extensions or improvements examined for the PMT. Because of the distances involved and the number of new vehicle service hours required to operate the service, the New Bedford/Fall River service would also be very expensive to build and operate. Capital costs are estimated to total $288 million. Annual operating costs would be $12.2 million per year compared to annual fare revenue of $2.6 million, or a revenue to cost ratio of only 22 percent. The reduction in regional emissions resulting from New Bedford/Fall River service (0.10 percent) would exceed those of most other commuter rail improvements examined.

In more detail, impacts would be as follows:

Ridership

The New Bedford/Fall River service would attract a higher number of total trips—6,465 per weekday—than any other commuter rail improvement examined except the North-South Rail Link. It would divert more automobile users to transit (2,820) than any extension except Worcester (3,200). By station, ridership would be:

Figure 9-20
New Bedford/Fall River Commuter Rail Service



North Easton	1,785
Raynham	555
Taunton Center	600
East Taunton	1,155
New Bedford	1,140
Freetown	630
Fall River	600
Total	6,465

Ridership at North Easton, East Taunton and New Bedford would exceed present ridership at the majority of MBTA commuter rail stations.

Costs and Cost-Effectiveness

The restoration of commuter rail service to New Bedford and Fall River would require total reconstruction of 15.8 miles of abandoned line between Stoughton and Whittenton Junction. Extensive upgrading of 28.3 miles of track between Cotley Junction and New Bedford and Fall River, now used only for local freight service, would be needed to meet passenger service standards. The remaining 3.8 mile segment between Whittenton Junction and Cotley Junction is part of Amtrak's summer weekend route from New York to Cape Cod. It was upgraded for this service in 1986.

The New Bedford/Fall River service would also require construction of seven new stations and two layover facilities. (Platform length and parking capacity at the Amtrak Taunton station are inadequate for commuter service.)

The most recent capital cost estimate for provision of commuter rail service to both New Bedford and Fall River is $288 million. This exceeds the cost of any commuter rail service improvement or extension project examined for the PMT except for the North-South Rail Link. The capital cost per new weekday rider would be $102,100. This would make it one of the less cost-effective commuter rail projects examined. (None of the more costly projects except the Rail Link are included in the recommended program.) Operating costs would increase by $12.2 million per year, while revenue would increase by $2.6 million. This would be a revenue to cost ratio of 22 percent.

A shorter extension of Stoughton service over part of the New Bedford/Fall River route could capture much of the ridership at far lower cost. In particular, an extension ending at East Taunton would attract 3,870 weekday riders including 2,265 new transit users. This would require a capital cost of $122 million, or $58,900 per new rider. Annual operating cost would be $4.4 million per year, and annual revenue $1.5 million, making a revenue to cost ratio of 34 percent.

Air Quality Impacts

A New Bedford/Fall River line would have larger air quality benefits than any commuter rail extension examined in the PMT. Regional emissions would be reduced by 0.10 percent. The cost to attain this would also be relatively high, at $3.5 million per kg of weekday VOC elimination. An extension to East Taunton only would have smaller total air quality benefits, reducing weekday emissions by 0.06 percent. This would still compare favorably with most of the other commuter rail projects. The cost per kg of weekday VOC elimination, $2.36 million, would be relatively low for a rail extension and similar to that of the Millis line.

Commuter Rail Service to Millis

As examined in the PMT, service to Millis through Dover and Medfield would be operated as a new line. It would share the same right-of-way as the Needham line between South Station and Needham Junction, and then continued to Dover, Medfield, and Millis via the Dover Secondary Track from Needham Junction to Medfield Junction (6.9 miles) and the Clicquot Secondary Track from there to Millis (2.2 miles).

There would be three stations on the extension:

Station	Parking	Fare Zone
Dover Center at Springdale Avenue	200 spaces	3
Medfield Junction at Adams Street	400 spaces	4
Millis, west of Village Street	400 spaces	5

As examined in the PMT, Millis service would not affect Needham Line service. The only stations that would be served by both lines would be Needham Junction, Hersey, and the inner stations. Needham Line service would continue to stop at all stations, while Millis service would operate express through West Roxbury, Roslindale, and Jamaica Plain. Stations in these neighborhoods would continue to be served by the Needham Line (see Figure 9-21)

Needham and Millis trains would both operate at 30 minute headways during peak periods. This would mean that all outer stations on the Needham and Millis lines would be served every 30 minutes, except Needham Junction and Hersey, which would be served by trains departing every 15 minutes. Current Needham Line passengers would be able to board Millis Line express trains at Needham Junction and Hersey stations. For these passengers, travel times would be reduced by 16 minutes. For other Needham Line passengers, slightly faster service attributable to 60 mph maximum speeds would reduce travel times slightly, or by one to four minutes.

Commuter rail service to Millis as described above would serve 1,820 weekday riders in 2020, including 855 new transit riders. These figures are in the mid-range for new commuter rail services examined for the PMT. However, the operating costs would be relatively high, at $5.6 million; with $1.2 million in annual fare revenue, the farebox ratio would be low at 21 percent. Air quality benefits, at a 0.03 percent reduction in regional emissions, would also be relatively low.

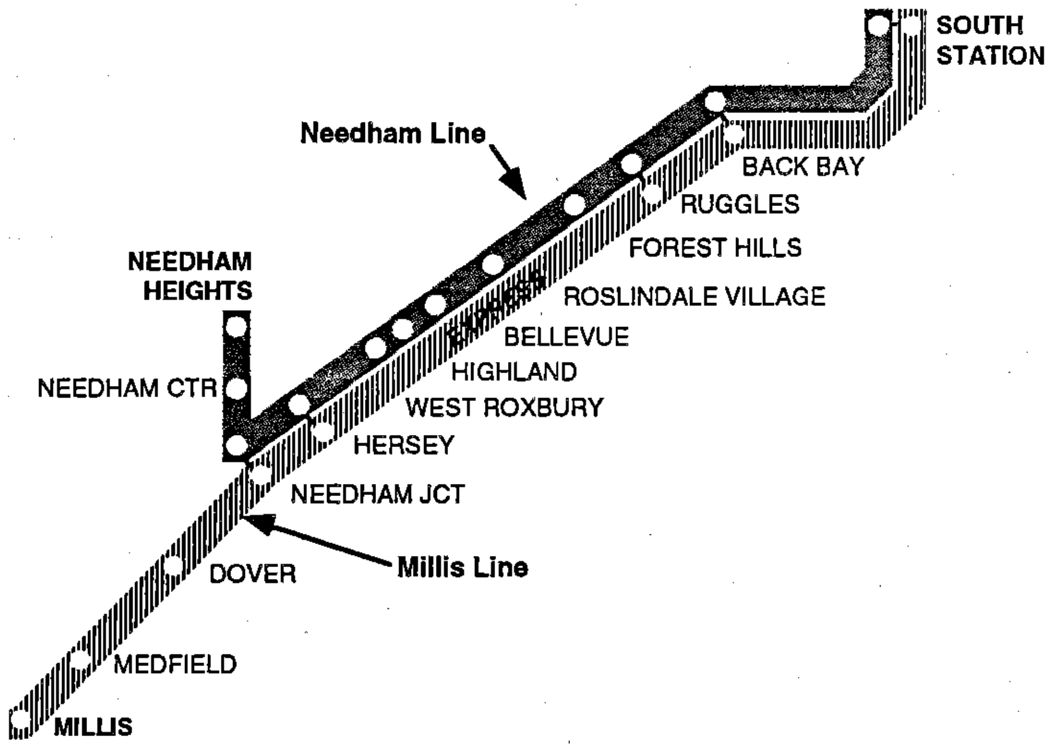
High operating costs for Millis service can be attributed to the way the alternative was defined for the PMT analysis. With further analysis, it may be possible to determine a more cost-effective operating strategy using a different split of service between Millis and Needham Heights.

In more detail, impacts would be as follows:

Ridership

The Millis service would attract a higher number of total trips—1,820 per weekday—than any commuter rail extension examined, except the Worcester and Fall River/New Bedford services. It would divert more automobile users to transit (860) than any service except Worcester, Fall River/New Bedford, and Newburyport. By station, ridership would be:

Figure 9-21
Millis Extension: Peak Period Service Configuration



Millis	760
Medfield	740
Dover	320
Total	1,820

At these ridership levels, the Millis and Medfield stations would have higher ridership than most of the Needham Line stations now do. They would also serve more riders than the majority of individual stations on other lines now serve.

Costs and Cost-Effectiveness

The restoration of passenger service to Millis would require the upgrading and signalization of 9.1 miles of track between Needham Junction and Millis. This line consists of a single track, and because of a number of cut and fill sections, it could be difficult to double track the line. The levels of service assumed for PMT purposes could be operated with a single track, and it was assumed that the right-of-way would be upgraded as a single track line. Between Needham Junction and Forest Hills, Millis service would share the same right-of-way with Needham trains. This single track section would need to be double-tracked to accommodate service on both lines. In addition, three new stations and a layover facility would need to be constructed. The total cost for the stations and right-of-way improvements would be $41.2 million. In addition, three new train sets would be needed at a total cost of $25.6 million. This would bring the total cost of the new service to $66.7 million. The capital cost per new weekday transit trip would be $78,000. This cost, while relatively high, is lower than the same costs for all commuter rail extensions examined except the Worcester and Newburyport extensions.

Millis service would increase operating costs by $5.6 million, and generate $1.2 million, or 21 percent of operating costs, in fare revenue. This service would be more expensive to

operate than most of the extensions because it would be, in effect, a new line. As a result, new service would need to be operated over the full length of the line between Millis and South Station, rather than just along an extended segment of an existing line. If Millis service were to be operated as an extension of the Needham Line, it would be necessary to discontinue or reduce service to Needham Center and Needham Heights. The option of discontinuing service to Needham Center and Needham Heights was tested early in the PMT process, but was dropped from further consideration because it would result in too large of a loss in Needham ridership. The option of splitting service beyond Needham Junction between Needham Heights and Millis was not tested in the PMT analysis, but may provide a lower cost way to achieve much of the potential ridership increase. These options deserve further examination.

Air Quality Impacts

The air quality benefits of Millis service would be relatively low, at a 0.03 percent reduction in regional emissions. The capital cost per kilogram of VOC eliminated per weekday would be $2.4 million. This cost would be moderately high.

Fairmount Commuter Rail/Red Line Connection

A connection between the Red Line and the Fairmount Line would consist of converting the Mattapan High Speed Line to Red Line service and extending it one-quarter of a mile from the current Mattapan Station to a new station at the Fairmount commuter rail line. This project would be the same as the "Red Line Extension to Mattapan" project, described above, with the addition of the one-quarter mile extension to the Fairmount Line (see Figure 9-22).

Weekday service on the Fairmount Line now consists of 30 minute headways during peak periods, and 60 minute headways during off-peak periods. These headways would be maintained and all Fairmount trains would stop at the new station. Also, all Ashmont Red Line service would be extended to the new station.

A connection between the Red Line and the Fairmount Line would serve the second greatest number of passengers of any of the connections examined (1,680 total trips per weekday). Construction of this connection would also require the conversion of the Mattapan High Speed Line to and extension of the Red Line. Conversion can not be justified by the connection, but the connection should be considered if the Mattapan High Speed Line is converted for other reasons.

In more detail, impacts would be as follows:

Ridership

A new station connecting the Red Line and the Fairmount Line would served 1,680 total trips per weekday, but only 190 new transit trips. Most of these trips would be made by those who now use Mattapan station; relatively few would be transfers between the Fairmount Line and the Red Line.

Note that these figures do not include new trips that would be attracted the conversion of the Mattapan High Speed Line to an extension of the Red Line between Ashmont and the existing Mattapan Station. That conversion would carry 4,720 total trips between the existing Mattapan Station and Ashmont, and 1,260 new transit trips.[18]

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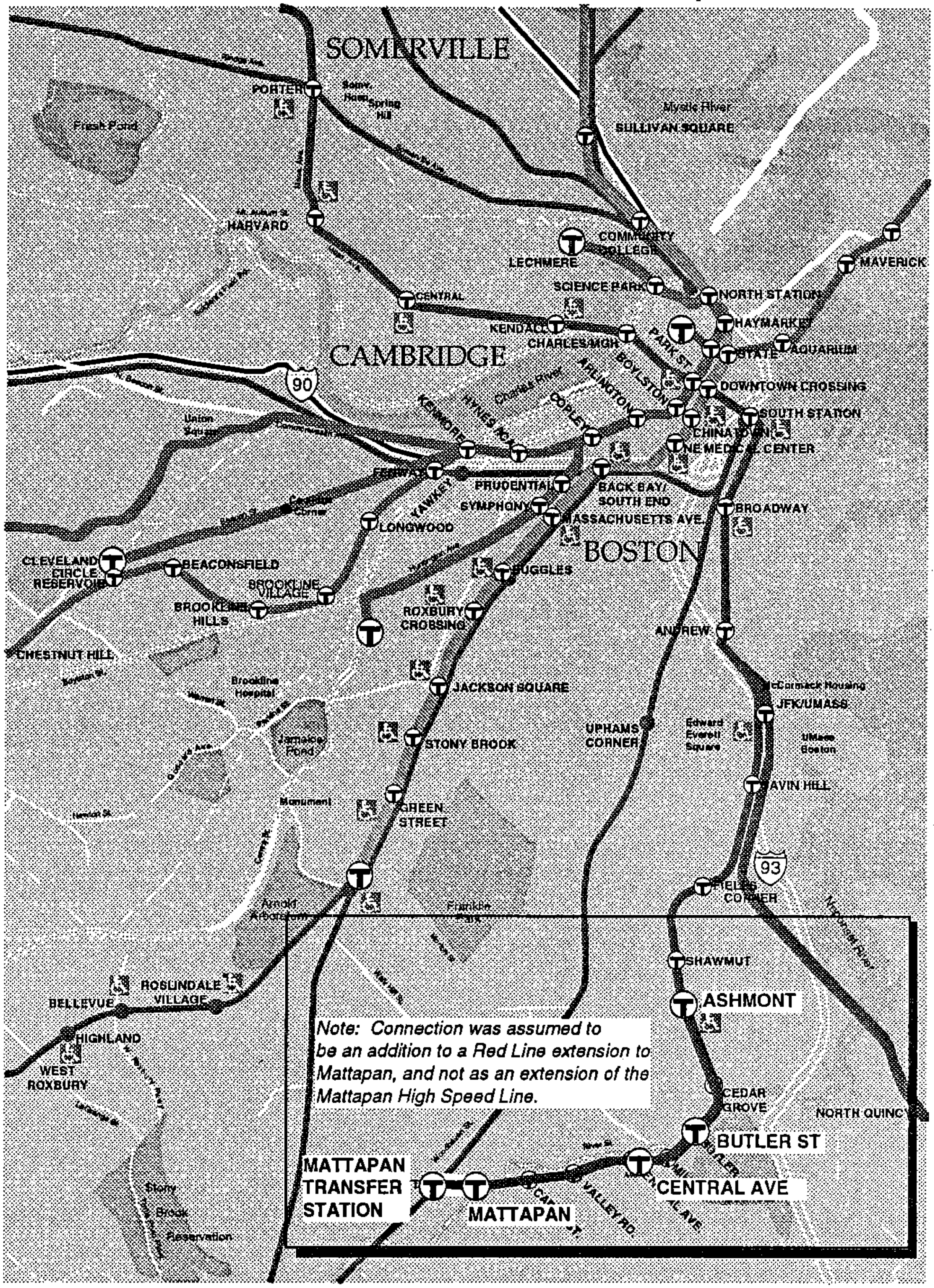
[18]For more information, see "Red Line Extension to Mattapan" section.

Figure 9-22
Red Line/Fairmount Commuter Rail Line Connection at Mattapan



Costs and Cost-Effectiveness

The connection between the Red Line and the Fairmount Line would require the conversion of the Mattapan High Speed Line to an extension of the Red Line. This would cost approximately $54.8 million. The construction of the additional one-quarter mile extension to the Fairmount Line and a new terminal station would add $8.2 million to the cost.

Additional operating costs would be approximately $125,000 per year. These costs would be attributable to the short extension of the Red Line from Mattapan. Additional commuter rail costs would be negligible. The connection would generate $43,000 per year in new fare revenue, or 35 percent of its operating costs.

The capital cost per new transit rider, at $43,100, is the highest of the six transfer projects examined.

Air Quality Impacts

A rapid transit/commuter rail connection near Mattapan would have a very low air quality benefits, resulting in a reduction in regional emissions of less than 0.01 percent.

New Connections to Logan Airport

The PMT analysis examined five new services to Logan Airport. These included new bus services from North and South Stations, a Blue Line spur into Logan Airport, and new express bus services from Newton Corner and Waltham. These services, and their impacts, are described in Appendix G.

It became evident during the PMT analysis that the examination of improved connections to Logan Airport requires a much broader study that includes a variety of non-MBTA services. It is recommended that a broader effort than was possible within the PMT be undertaken to address this issue.

Route 128 Bus Service

The majority of public transit in the Boston region is a traditional hub-and-spoke network of commuter rail, bus and rapid transit lines leading to downtown Boston. For suburb- to-suburb commutes, which comprise the majority of work trips made within and to the Boston area, transit has generally not been expanded due to difficulties in adequately serving dispersed trip origins and destinations. Development in the 1980s has increased the density of trip attractors (office, industrial and commercial employment) and trip producers (residential development) to the extent that it may be possible to institute successful services.

The PMT analysis examined one alternative for service that would operate nearly the entire length of Route 128. This analysis indicates that Route 128 bus service could divert a relatively large number of automobile users—up to 3,470 per weekday—to transit. Further, the capital cost of implementing the service would be low relative to the number of new riders that would be attracted. However, there are also a large number of negatives to the service. First, it would be expensive to operate (up to $4.8 million per year), and be lightly utilized relative to the amount of service that would be provided. In terms of the number of

passengers per vehicle service mile and per vehicle service hour, a Route 128 bus service analyzed in the PMT would perform well below minimum MBTA standards.

Also, the PMT analysis assumed a cooperative effort whereby the MBTA would provide the Route 128 service and that connecting shuttle services would be privately financed and operated. This would require a major (and probably time consuming) effort on the part of the MBTA and local cities, towns, developers, and/or transportation management agencies to set up connecting shuttle services. This project could be an experiment in privatization and/or a public/private partnership.

Finally, as mentioned above, the PMT analysis examined only one alternative for Route 128 bus service, and that this alternative was designed to provide service to the entire corridor. The resulting ridership projections indicate that there is a demand for service, but not for the level or extent of service that was examined. It is possible that more modest bus services could achieve much of the same ridership increases at lower costs. The examination of additional options was beyond the scope of the PMT analysis; subsequent work on Route 128 bus services should focus on this area.

Additional detail on the alternative examined in the PMT are as follows:

Project Description

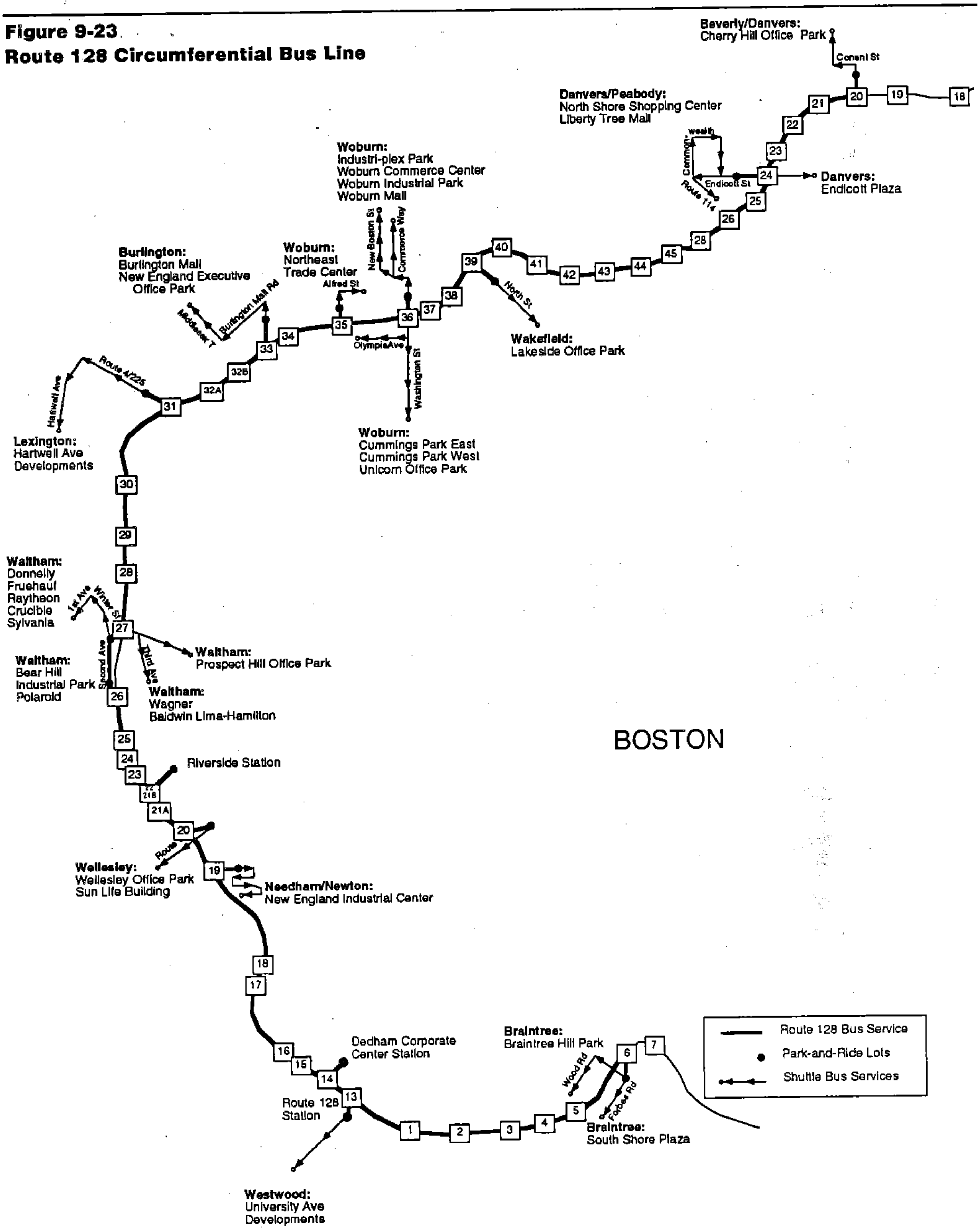
For a Route 128 bus service to be able to compete with automobile trips, it would need to be convenient, cost-competitive and have a reasonable travel time. So that bus travel times would be reasonable, Route 128 service would need to stay on Route 128 to the greatest extent possible. To do this, it would exit the highway only to make stops at major interchanges, with local collection and distribution provided through park-and-ride lots located at major interchanges and shuttle services to and from worksites. Most trips would involve two transfers. In the morning, the first would usually involve an automobile trip from home to a Route 128 bus stop at a park and ride lot. The second would be from the Route 128 bus to a shuttle to the final destination.

For the PMT analysis, service was designed to serve the largest work trip attractors along the Route 128 corridor (see Figure 9-23), with station sites selected to satisfy two criteria: (1) multiple major employment centers within a roughly 3.5 mile radius of the bus stop, and (2) the existence of local arterial roads that could provide good radial access. The second attribute is particularly important because it would minimize automobile travel time to and from the commuter's point of origin.

Most potential riders Route 128 bus riders live in areas that do not have bus service. Therefore, park and ride lots would be necessary to provide for auto access to the route. For the PMT analysis, in order to determine the maximum ridership potential, it was assumed that park and ride lots would be located at each interchange that would be served by a Route 128 bus route. Further, all park-and-ride lots would be located immediately adjacent to Route 128 interchanges (to minimize off ramp and on ramp travel time) unless otherwise noted. Parking for at least 100 cars would be provided and offered free of charge. Stops and park-and-ride lots would be sited at the following locations:

Interchange	Radial Collector/Distributor	Community
Exit 20	Route 1A	Beverly
Exit 24	Endicott Street	Danvers
Exit 39	North Street	Wakefield
Exit 36	Washington Street	Woburn

Figure 9-23.
Route 128 Circumferential Bus Line



Interchange	Radial Collector/Distributor	Community
Exit 35	Route 38	Woburn
Exit 33	Route 3A	Burlington
Exit 31	Route 4/225	Lexington
Exit 27	Winter Street	Waltham
Exit 26	Route 20	Waltham
Exit 22/21B	Riverside Station	Newton
Exit 20	Route 9	Wellesley
Exit 19	Highland Avenue	Needham
Exit 14	Dedham Corporate Center Station	Dedham
Exit 13	Route 128 Station	Dedham
Exit 6	Route 37	Braintree

Shuttle services would provide connections between bus stops and worksites. For these purposes, it was assumed that shuttle services would operate at the same frequency as the Route 128 bus, with timed connections. For the PMT alternative, this involved sixteen separate shuttle services with run times of between 8 and 23 minutes. Shuttle bus trip lengths ranged from approximately 1.5 miles in Wakefield to 3.5 miles in Lexington.

Ridership

The provision of bus service on Route 128 with park and ride lots and connecting shuttle services would carry approximately 3,470 trips per weekday. Virtually all of these trips would be new transit trips. Further, nearly all of these trips would be made by those that would access the route by automobile (98 percent), and most of the trips would be relatively long trips (an average of 13.5 miles). The relatively long trip length is a function of the two transfers since the time and inconvenience of the transfers would be more of a disincentive for shorter trips than for longer trips.

With 3,470 new transit trips per weekday, Route 128 bus service would divert a high number of trips from automobiles to transit—more than any commuter rail project except the North Station - South Station Rail Link, and more than most rapid transit projects. However, most of the reason that ridership would be high is that a very large amount of new service would be added. At 55.6 miles, this route would be, by far, the longest in the MBTA system. In terms of the amount of new service that would be provided, ridership would be low. The number of total passengers per vehicle service mile (VSM), and per vehicle service hour (VSH), would be 0.7 and 13.3 respectively. These figures are well below the MBTA's minimum service standards of 1.5 passengers per VSM and 30 passengers per VSH for bus service.

Further, it should be stressed that the full 3,470 trips could be attracted only if the bus service supported by the park and ride lots and shuttle services. Few trips would be made by those who could walk to the bus at both ends. As a result, if Route 128 bus service were instituted without these supporting facilities and services, ridership would be extremely low.

Costs and Cost-Effectiveness

The institution of bus service along Route 128 would require a number of actions:

1) Construction of park and ride lots and associated stop facilities.
2) Purchase of buses.
3) Institution of connecting shuttle services.

The construction of park and ride lots and stop facilities and the purchase of the 24 buses needed to operate the service would cost $7.9 million. The connecting shuttle services, if contracted for in the same manner as most existing suburban mini-bus services, would not have an associated capital cost; capital costs instead would be built into the contract cost for the operation of the service. The $7.9 million cost of the park and ride lots and the 24 Route 128 buses, divided by 3,470 new riders, translates into a capital cost per new transit rider of $2,300. This would be one of the lower costs among PMT projects that would generate significant new ridership.

Because of the length of the route, and the level and span of service that would be provided, operating costs would be high, at $4.8 million per year. The new ridership, which would be low compared to the amount of new service provided, would generate $0.9 million in new fare revenue, or 18 percent of operating costs. This percentage is lower than the 33 percent standard, but is similar to the 22 percent ratio for all existing bus service combined.

Air Quality Impacts

Route 128 bus service would have a relatively large positive benefit on air quality, resulting in a reduction in regional emissions of 0.05 percent. The resulting capital cost per kilogram of VOC eliminated, at $180,000 is higher than for most other bus projects.

Chapter 10
Funding / Implementation

As detailed in the previous chapters, the PMT analysis has identified a large number of new services that could provide transportation and air quality benefits to the region. In the evaluation of individual projects, these benefits were considered in terms of each project's costs. On a broader level, the benefits of individual projects, and the program as a whole, must be considered in terms of the amount of funding that will be available, transportation needs in other parts of Massachusetts, and other needs within the Commonwealth. This chapter addresses funding issues related to the PMT and the impact that funding will have on implementation of the program.

Primary MBTA Capital Funding Sources

The MBTA receives most of its capital funding through the Federal Transit Administration (FTA) and from the state. Since 1987, most federal funding has consisted of a mix of Section 3, 9 and 23 funds:

Section 3 is discretionary capital funding allocated on the basis of project merit, with projects competing on a nationwide basis. This source consists of two major components: New Starts and Rail Modernization.

As detailed below, the amount of Section 3 funds varies significantly from year-to-year. For example, the MBTA received a low of $43 million in FY 1989, but expects to receive $150 million in FY 1994.[1] Most of the variation occurs in the New Starts portion, which funds major expansion projects such as the South Boston Piers Transitway. The other element, Rail Modernization, is more stable. The Boston MPO received $47.6 million in Rail Modernization funds in FY 1993, and it expects to receive funding at a similar level for the near-term future.

Section 9 is a formula grant, and although it can fluctuate depending on the annual appropriation by Congress, it is relatively stable. The Boston MPO received $26.6 million in Section 9 capital funds in FY 1993 and it expects to receive funding at a similar level for

[1]Unless otherwise noted, all dollar figures in this section are presented in 1993 dollars. Past revenue figures were inflated to 1993 dollars based on the CPI. For 1993 and future years, inflation was assumed to be 3.5 percent per year.

the near-term future. (Note that Section 9 also includes funds for operating assistance; these funds are not included herein.)

Section 9 funds are flexible, but the MPO is not allowed to transfer these funds to highway purposes unless it can document that all the requirements of the Americans with Disabilities Act (ADA) have been carried out. This stipulation virtually guarantees that Section 9 funds will be used for transit, because of the huge investment needed to satisfy the conditions of the ADA.

Section 23 is interstate transfer funding, which consists of funding initially earmarked for interstate highway projects but subsequently transferred to transit projects, including the Alewife extension and the new Orange Line. This source will expire in FY 1994. The MBTA had previously received up to $120 million from this source (in FY 1987).

In addition to Section 3, 9 and 23 funding, ISTEA created two new categories of "flexible" funding. These categories are Surface Transportation Program, or "STP", and Congestion Mitigation/Air Quality, or "CMAQ." These funding categories are administered by the Federal Highway Administration, but based on action by MPOs, can be transferred to the FTA for distribution for transit projects. The Boston MPO has acted to transfer between $28 and $37 million per year in flexible funds to the MBTA for FYs 1992 through 1995. It has been established, in principle, that additional funds be transferred in FYs 1996 and 1997. However, beyond committed funds, MBTA needs will have to be considered with highway needs for available flexible funding.

State capital funding is largely in the form of bond revenues. The sale of bonds by the MBTA is authorized by the state, with subsequent repayment funded by the state through the MBTA's operating budget.

Past and Present Capital Funding and Spending

Due largely to fluctuations in receipts from federal funding sources, MBTA capital funding often varies significantly from year-to-year. From FY 1987 and 1991, the MBTA received from $336 million to $409 million per year in total federal and state funding. For the period FY 1992 to 1995, the range will be larger, from $330 million to $517 million per year.

FY 1987 to FY 1991

The total of federal and state funding between FY 1987 and FY 1991 ranged from $336 and $409 million per year. Federal funding during this period was authorized by the Surface Transportation and Uniform Relocation Assistance Act (STURAA), which preceded ISTEA. Federal capital funds received under this act consisted of Section 3, Section 9, and Section 23 funds. The total received from these three sources ranged from $81 to $182 million (see Table 10-1). The high amounts of federal funding in FY 1987 and 1988 largely reflected receipts of interstate transfer (Section 23) funding for the new Orange Line.

State funding was somewhat more stable, ranging from $155 million in FY 1987 to $261 million in FY 1989.

Table 10-1
Transit Funds Spent by the Boston MPO 1987-1991
(All figures in 1993 dollars)

	FY1987	FY1988	FY1989	FY1990	FY1991
Federal					
Section 3	$60,315,354	$82,212,965	$42,570,851	$65,246,969	$46,655,477
Section 9	$1,047,332	$45,907,356	$38,549,933	$25,705,951	$30,567,382
Section 23	$119,687,777	$53,761,081	$51,162,994	$17,751,614	$3,523,396
Total Federal	$181,050,464	$181,881,402	$132,283,778	$108,704,534	$80,746,256
State					
MBTA Bonds	$155,015,082	$227,555,445	$260,709,266	$239,061,136	$259,911,347
Total Transit Funds	$336,065,546	$409,436,847	$392,993,044	$347,765,670	$340,657,604

Note: State bond revenues shown in Table 10-1 are actual bond sales inflated to 1993 dollars.
Source: MBTA

FY 1992 to FY 1995

From FY 1992 and 1995, the MBTA has received, or can reasonably expect to receive, from $330 million to $517 million per year in total federal and state funding. Federal funding during this period is authorized under ISTEA. Under this act, the major FTA sources are Section 3 and 9, with a phase out of Section 23. STP and CMAQ funding, which can be used for transit and highway projects, were also introduced under ISTEA.

From FY 1992 to FY 1995, as in the recent past, federal funding is expected to vary significantly from year-to-year from a low of $123 million in FY 1992 to a high of $228 million in FY 1994 (see Table 10-2). These fluctuations are largely due to changes in discretionary funding, with the higher Section 3 amounts representing funding for Old Colony restoration and the South Boston Piers Transitway.

In the flexible funding categories—STP and CMAQ—the Boston MPO has acted to have money transferred from the Federal Highway Administration to FTA for two large projects, the South Station Bus Terminal and the Old Colony Railroad restoration, as well as a number of small projects.

State funding is expected to continue to be more stable than federal funding. For the period FY 1993 to FY 1997, the MBTA's Board of Directors has adopted a cap on total state bond funds of $1.48 billion (or roughly $300 million per year). This figure represents the maximum amount of funding that could be available. In practice, the highest amount of bonds that has been sold by the MBTA in any given year was $275 million in FY 1992 ($285 million in 1993 dollars). In 1993 dollars, a $300 million dollar annual bond cap represents state bond funding of $290 million for FY 1994 and $280 million for FY 1995.

Table 10-2
Transit and Flexible Funds Programmed by the Boston MPO under ISTEA
(All figures in 1993 dollars)

	FY1992	FY1993	FY1994	FY1995
Federal				
Section 3	$52,767,374	$85,544,573	$149,544,355	$97,824,847
Section 9	$36,279,342	$26,592,000	$37,176,056	$36,045,843
Section 23	$5,544,198	$1,015,631	$3,695,385	$0
Flexible Funds	$28,149,964	$32,243,150	$37,101,665	$34,353,510
Total Federal	$122,740,878	$145,395,354	$227,517,460	$168,224,200
State				
MBTA Bonds	$284,956,353	$185,400,000	$289,834,113	$280,032,960
Total Transit Funds	$407,697,231	$330,795,354	$517,351,574	$448,257,160

Notes / Assumptions: All flexible Section 9 funds assumed for transit use through 1995. State bonds for 1992 and 1993 are actual sales. Figures for 1994-1995 are the 1993 dollar equivalents of the MBTA Board of Directors' $300 million bond cap. Inflation for future years is assumed at 3.5%.
Sources: MBTA, Boston MPO Transportation Improvement Program

FY 1996 and FY 1997

For FYs 1996 and 1997, which are the final two years of ISTEA, future funding is less certain than through FY 1995. However, current estimates are that $481 and $413 million in combined federal and state transit funding will be available (see Table 10-3). This will include $210 and $152 million in federal funding, and $271 and $261 million in state bond funding.

Future Funding

As described above, MBTA capital funding consists of a mix of federal and state funds, some of which are relatively stable from year to year (Section 9 and Bond Funds), and some of which vary greatly from year-to-year (Section 3 and Flexible Funds). On an overall level, because funding from sources that can vary greatly comprise a large proportion of total capital funding, past receipts cannot be used to predict future funding levels with any reasonable degree of certainty on a year-to-year basis. Also, it is not possible at this time to foresee what the intent of Congress will be in 1997, when ISTEA expires, and a new transportation act will need to be enacted.

However, over time, federal discretionary funding has tended to be distributed in a manner that provides a degree of equity throughout the nation. As a result, years with relatively low receipts are often preceded and succeeded by years with relatively high receipts. Therefore, rather than attempt to forecast future funding on a year by year basis, past trends have been used to develop "average annual" figures that can be used as an indication of potential future funding levels over time:

Table 10-3
Future Funding [2]
(All figures in 1993 dollars)

	FY1996	FY1997
Federal		
Section 3	$125,902,097	$101,777,092
Section 9	$48,070,070	$24,050,067
CMAQ/STP	$36,075,100	$26,141,376
Total Federal	$210,047,267	$151,968,535
State Funding		
Bonds for Transit	$270,582,812	$261,432,669
Total Transit Funding	$480,630,079	$413,401,204
Additional Flexible Funds[2]	$54,116,562	$52,286,533

Source: MBTA

Federal Section 3, 9, and 23 Funding

For the future, it can be reasonably assumed that Section 3 will continue to be the largest source of federal transit capital. As described above, these funds are distributed by the FTA among competing transit systems nationwide on a project-by-project basis, and the amounts received vary greatly from year to year. On a year-to-year basis, changes in funding have ranged from a drop of 52 percent from FY 1988 to 1989 to an increase of 75 percent from FY 1993 to 1994.

Section 9 funds are formula grants distributed annually on a percentage basis. After a sharp increase from $1 million in FY87 to $46 million in FY88, funding declined somewhat and has now entered a period of relative stability. The appropriation by Congress is the main factor affecting changes in funding levels from year to year. The MBTA expects Section 9 funding to hover in the range of $35 million for the foreseeable future.

Section 23 Interstate Transfer funds have been steadily diminishing and will end after FY94. However, for the period FY 1987 to 1995, declines in Section 23 funding have generally been offset by increases in Section 3 funding.

When measured in 1993 dollars, the total average annual amount of FTA funding that the MBTA has received, or expects to receive, is essentially the same under ISTEA as it was under STURAA, at $137 million to $143 million:

[2]Estimates of Section 3, Section 9 funding were supplied by the MBTA, and are dependent upon annual appropriation by Congress. The flexible CMAQ/STP funding represents the commitment by the Boston MPO to use flexible funds to fund the Old Colony project at an 80/20 Federal/state ratio. The full $300 million per year bond cap was used for state funding estimates, deflated to 1993 dollars. The "Additional Flexible Funds" amounts are based on the November 18, 1992 vote of the Boston MPO.

	STURAA (FY87 - FY91)	ISTEA (FY92 - FY97)
Low	$81m	$95m
High	$182m	$190m
Average	$137m	$143m

Federal Flexible Funds

The transfer of STP and CMAQ flexible funds were made specifically for the South Station Bus Terminal and Old Colony projects and range from $28 to $37 million between FY 1992 and FY 1997. In future years, both transit projects and highway projects will be eligible for these funds. Since highway needs have not been fully developed at this time, it is not possible to predict the relative needs of future transit and highway projects. Therefore, the amount of potential future flexible funds cannot be reasonably projected at this time.[3]

State Bond Funding

The fixed cap on state bonds means that the amount of state money available for transit will decline over time in real terms. Up to the present time, the MBTA has not reached the cap in any year, and the FY1993 bond sale of $185.4 million was well below the authorized limit. Through FY 1997, the $300 million figure is retained as the maximum available state funds per year. For the period FY 1993 to FY 1997, the $1.5 billion dollar bond cap represents average annual funding in 1993 dollars of $280 million.

Over the period FY 1992 to FY 1997, the MBTA has received, or can reasonably expect to receive, an average of $143 million per year in FTA funding, and an average of $280 million in state bond funds. In total, this represents an average of $423 million per year available in dedicated transit funding. Any flexible funding would be in addition to this amount.

PMT Costs versus Expected Capital Funding

Capital costs associated with MBTA service typically vary significantly from year-to-year. The variation is typically associated with the types of infrastructure reinvestment projects required (as described in Chapter 6), and the type and scope of expansion projects that are being undertaken. For the future, the MBTA will have some degree of flexibility in the phasing of projects to match funding availability. Significant exceptions are the SIP and CA/T Mitigation projects, most of which have implementation deadlines.

Because most of the projects in the PMT that are recommended as desirable still need to undergo environmental review, it is premature to attempt to project implementation timeframes on a year-to-year basis. In recognition of this, and that there will be flexibility in the phasing of most projects, costs and funding have been examined on the basis of average annual costs and average annual funding availability for the short-term (through 2000) and for the long-term (2001 to 2020).

As described in Chapter 5, the first priority of the PMT is to ensure preservation of the existing system. Next, the highest priorities are to make the system accessible and to meet

[3]For additional information on highway needs and broader information on funding issues as they pertain to both highways and transit, refer to "The Transportation Plan for the Boston Region," November 1993, produced by CTPS for the Boston MPO.

SIP and CA/T Mitigation requirements. The implementation of projects in these three categories will require average annual expenditures of $468 million.

Over the longer-term, as the system is made accessible and SIP and CA/T Mitigation requirements are met, costs to preserve the existing system and other mandated expenses will be significantly lower (at approximately $330 million per year) which should leave funding available for additional expansion. However, the cost of all the Additional Expansion projects, averaging $300 million per year, would exceed the amount of funding that has been available in prior years.

Reconciling Costs with Available Funding

For the PMT to be a responsible program, it must be implemented within the constraints of available funding. The total cost of the projects included in the recommended program exceeds the amount of capital funding that is likely to be available. This is not intended to imply that more money will be made available or that all the recommended projects will prove out, but instead to reflect that some issues still need to be resolved:

- The amount of future federal funding cannot be predicted with any degree of certainty, but it might be higher in the future than it has been in the past. At this time, it appears that a large federal grant would be sought to fund the Rail Link, and that funding under the Section 3 New Start (or similar) program would have to be pursued for the Inner Circumferential Transit project.

- While the PMT analysis examined all projects on the basis of ridership, cost, traffic, and air quality characteristics, most projects would still need to undergo significantly more detailed environmental review before they could be implemented. It is likely that some of the projects would have environmental and/or community impacts that would make them less desirable than they now appear, and thus will not be implemented. This would reduce the size of the program.

- The MBTA's transit needs, as presented in this PMT, still need to be examined within the context of the other regions' transit needs, and relative to the state's highways needs. This multimodal analysis, which will be conducted in the context of the ISTEA long-range plans supported by the management systems and the work of EOTC's Capital Finance Review Committee, will determine the amount of flexible funding that may be available. The figures presented above for the long-term do not assume any allocation of flexible funding to transit projects; such an allocation would increase the size of the transit program that could be implemented.

- Substitutions for some SIP and CA/T Mitigation projects may be desirable. As described in Chapter 8, the SIP and CA/T Mitigation projects that were examined in the PMT analysis have merit in terms of ridership and/or air quality benefits. However, some of those projects do not represent the most cost-effective way to achieve those benefits. Substitutions may allow for the implementation of some of the short-term additional expansion projects.

- This PMT addressed needs over a 27 year period that extends to 2020. This analysis was based on current projections of growth and land use through that time. Changes will occur during this period that cannot be predicted, which may alter the effectiveness of some projects. These types of changes could either increase or reduce needs.

The inclusion of a larger number of projects in the recommended program than can likely be funded is intended to provide flexibility to respond to future demands placed on the transportation system. On a year-to-year basis, or for any given period of years, it will be necessary to implement the most effective projects within the limits of the amount of funding that will be available.

Finally, it should once again be noted that the PMT is one part of an ongoing planning process that includes the development of regional and state Transportation Plans and ISTEA management plans. It is likely that the development of these plans will make further refinements to the PMT desirable.

Schedule for Implementation

In the near-term, most priorities have been effectively set by inclusion of projects in the SIP and by the state Department of Environmental Protection (DEP) in its CA/T rulings. Implementation dates for these projects are as follows:

1992:	400 New Buses
1994:	South Station Bus Terminal (underway) Washington Street Replacement Service Newburyport Commuter Rail Extension
1995:	New Orange Line Vehicles 2 Commuter Boat Facilities (Fort Point Channel)
1996:	10,000 Additional Parking Spaces by 12/31/96 Old Colony Commuter Rail Restoration (underway) Worcester Commuter Rail Extension
1997:	Green Line Arborway Restoration
1998:	Blue Line Station Modernization
1999:	10,000 Additional Parking Spaces by 12/31/99
2001:	South Boston Piers Transitway
2011:	Blue Line - Red Line Connector Green Line Extension to Tufts

EOTC, the MBTA, and the CA/T Project are now addressing funding issues and implementation dates related to these projects. As discussed previously in this document, there are outstanding issues related to some of these projects, and it may be necessary or appropriate to consider substitutions for certain projects (400 New Buses, Newburyport Commuter Rail Extension, and 2 Commuter Boat Facilities). As outstanding issues are resolved, the projects and/or implementation dates may change.

At this time, funding for all of the SIP and CA/T Mitigation projects has not been identified. However, as discussed in the previous section, the costs to preserve the existing system, to make the system accessible, and to implement SIP and CA/T Mitigation projects through

2000 will be higher than the amount of funding that has been available for similar periods in the past. Given this situation, specific implementation dates have not been developed for the Short-Term Additional Expansion projects. While these projects are desirable before 2000, the funding issues related to SIP and CA/T Mitigation projects must first be resolved before it can be determined whether funding will be available for additional expansion. Only after this has been done can specific implementation dates be considered.

Over the long-term, as SIP and CA/T Mitigation requirements are met, it is expected that funding will be available for additional expansion. However, until the short-term issues are resolved, it would also be premature to attempt to set specific implementation dates for each long-term project. Instead, long-term Additional Expansion projects should be considered within a general category of projects having implementation dates after 2000.

Figure 10-1 provides a timeline up to the year 2020, showing in which five-year period the recommended PMT projects may be completed. Scheduling projects ten to thirty years in the future is tentative at best. This timeline is therefore presented to give the reader a sense of the extent of the transit system at five-year intervals.

Figure 10-1
Projected Timeline of PMT Projects

1994–2000	2001–2005	2006–2010
Old Colony Commuter Rail - 3 branches	South Boston Transitway - South Station to Boylston	Red–Blue Connector
Worcester Commuter Rail	Arborway Restoration/Replacement	Green Line to Medford Hillside
South Boston Transitway - So. Sta. to WTC	Rockport/Ipswich Commuter Rail/Blue Line Connection	Blue Line Extension to Lynn
Washington Street Replacement Service	North Station–South Station Rail Link Phase 1	New Bedford/Fall River Commuter Rail Service
Inner Circumferential Bus Service	Needham Commuter Rail Improvements/New Stations	New Connections to Logan Airport
Newburyport Commuter Rail	Green Line Improvements	Expansion of Park and Ride
Express Service on Commuter Rail lines	Route 128 Bus Service	Accessibility
Expansion of Park and Ride	Expansion of Park and Ride	Red Line Vehicles
New Express Bus	Accessibility	Orange Line Vehicles
Better Downtown Bus Distribution	Red Line Vehicles	Blue Line Vehicles
Key Station Plan	Green Line Vehicles	Green Line Vehicles
Other Accessibility	Commuter Rail Vehicles	Commuter Rail Vehicles
Blue Line Modernization	Bus Replacement	Bus Replacement
North Station Transportation Center	RIDE Vehicles	RIDE Vehicles
South Station Bus Terminal	Other Infrastructure Reinvestment	Other Infrastructure Reinvestment
Boston Engine Terminal		
Fare Collection Equipment	**2011–2015**	**2016–2020**
Red Line Vehicles	Inner Circumferential Transit Line	North Station - South Station Rail Link Phase 2
Orange Line Vehicles	Red Line to Mattapan	Fairmount Commuter Rail/Red Line Connection
Green Line Vehicles	Commuter Rail to Millis	Commuter Rail Vehicles
Commuter Rail Vehicles	Commuter Rail Vehicles	Bus Replacement
Bus Replacement	Accessibility	RIDE Vehicles
RIDE Vehicles	Bus Replacement	Other Infrastructure Reinvestment
Other Infrastructure Reinvestment	RIDE Vehicles	
	Other Infrastructure Reinvestment	